INFOCHANGE

agenda

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ENERGY vs ENVIRONMENT
The big challenge of the new millennium

How is climate change linked to energy use?

How can India's galloping economic growth and insatiable appetite for energy be balanced with environmental security?

FOR PRIVATE CIRCULATION

Flaws in the pro-nuclear argument

Flailing nuclear establishments worldwide are using global warming as an opportunity to resurrect an industry that has collapsed because of its inability to provide clean, safe, or cheap electricity. India too is forging ahead. Thousands of crores of investment later, just 3% of India's installed electricity-generation capacity comes from nuclear energy

M V RAMANA
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And it is worthy of note that the systems which the Europeans have discarded are the systems in vogue among us. Their learned men continually make changes. We ignorantly adhere to their cast-off systems.

— Mahatma Gandhi, *Hind Swaraj*

NUCLEAR POWER is in the news these days in a new incarnation — as an environmentally sustainable source of electricity. For example, the recent 'Declaration by India and France on the Development of Nuclear Energy for Peaceful Purposes', signed in February 2006, begins with the "recognition" that "nuclear energy provides a safe, environment-friendly and sustainable source of energy". The sheer audaciousness of terming a technology that was responsible for perhaps the most destructive industrial accident ever — the Chernobyl explosion of April 1986 — safe, cannot but cast doubt on the rest of those contentions. And yet, by being repeated time and again, such claims do begin to resonate with the public and gain acceptance. It is therefore necessary to look beyond the glossy exterior and analyse why nuclear power is not sustainable. As we argue below, it is neither environment-friendly, nor safe, nor economical.

This new incarnation of nuclear energy has arisen in the context of increasing global warming. Pro-nuclear advocates have offered nuclear power as a solution to global warming, and given the gravity of the likely impact of impending climate change, it is not surprising that many have started looking at it more favourably. Flailing nuclear establishments around the world have grabbed this second opportunity and made claims for massive state investments, in the hope of resurrecting an industry that has collapsed in country after country due to its inability to provide clean, safe, or cheap electricity.

Two implicit but flawed assumptions underlie such claims about the significance of nuclear energy in controlling climate change. The first is that climate change can be tackled without confronting and changing Western, especially American, patterns of energy consumption — the primary causes and continuing drivers of unsustainable increases in carbon emissions and global warming. This is impossible; global warming cannot be stopped without significant reductions in the current energy consumption levels of Western/developed countries. Efforts by various developing countries, especially by elites within such countries, to match these consumption levels only intensify the problem.

The second is that the adoption of nuclear power makes sense as a strategy to lower aggregate carbon emissions. A good example is Japan, a strongly pro-nuclear energy country. As Japanese nuclear chemist and winner of the 1997 Right Livelihood Award, Jinzaburo Takagi showed, from 1965 to 1995, Japan's nuclear plant capacity went from zero to over 40,000 MW. During the same period, carbon dioxide emissions went up from about 400 million tonnes to about 1,200 million tonnes. In other words, increased use of nuclear power did not really reduce Japan's emission levels. The massive expansion of nuclear energy, then, was not motivated by a desire to reduce emissions. If indeed Japan were sincere about doing that, it would have adopted very different strategies.

There are two reasons why increased use of nuclear power does not necessarily lower carbon emissions. First, nuclear energy is best suited only to produce baseload electricity, which only constitutes a fraction of all sources of carbon emissions. Other sectors of the economy where carbon dioxide and other greenhouse gases are emitted, such as transportation, cannot be operated using electricity from nuclear reactors. This situation is unlikely to change anytime soon.

A second and more fundamental reason is provided by John Byrnes of the University of Delaware's Centre for Energy and Environmental Policy, who observes that nuclear technology is an expensive source of energy and can be economically viable only in a society that relies on increasing levels of energy use. Nuclear power tends to require and promote a supply-oriented energy policy, and an energy-intensive pattern of development, and thus, in fact, indirectly adds to the problem of global warming.

Though not motivated by such radical and far-reaching analysis, even mainstream environmentalists recognise that building new nuclear plants is not an answer to tackling climate change. For instance, a major 2006 report by the United Kingdom (UK) government's Sustainable Development Commission (SDC) concludes that doubling nuclear capacity in Great Britain would have only a small impact on reducing carbon emissions by 2035. In addition, the report identifies the following five major disadvantages to nuclear power:

- No safe long-term solution to the problem of radioactive waste from nuclear plants is available, let alone acceptable to the general public.
- The economic costs of nuclear power are uncertain but much

higher than those of alternative sources of generating electricity.

- Nuclear energy requires and will lock the country into a centralised distribution system for many decades, and hinder the development of distributed energy-generation technologies that are rapidly emerging as important sources of electricity.
- The signal offered by nuclear programmes that what is needed to tackle climate change is just a major technological fix undermines energy efficiency imperatives.
- There are several safety and security risks associated with nuclear proliferation.

All of these factors are just as relevant in India as in the UK; to these one might add some more based on our own atomic history. Let us take a closer look at the Indian atomic energy programme, which will illustrate or adumbrate some of the points made by the UK Sustainable Development Commission.

India's nuclear establishment: Promising much, delivering little

The Indian nuclear establishment, like similar institutions elsewhere but only more dramatically so, has historically promised much and delivered little. Since its inception, the Department of Atomic Energy (DAE) has been promoting nuclear power as the answer to our energy needs. According to the DAE's predictions, by 2000 there should have been 43,500 MW of nuclear-generation capacity in the country, while what has been realised even now is only 3,310 MW, less than 3% of the installed electricity-generation capacity. Even by the DAE's projections, this will not become a significant fraction of India's electricity for the next few decades.

Such continued failures are not because of lack of resources. Practically all governments have favoured nuclear energy and the DAE budgets have always been high — a trend that has intensified after the 1998 nuclear weapons tests. According to the Union expenditure budgets, the DAE's budget estimate has increased from Rs 1836.53 crore in 1997-98 to Rs 5505.08 crore in 2006-07, ie, it has more than doubled even in real terms.

The high allocations for the DAE come at the cost of promoting other more sustainable sources of power. In 2002-03, for example, the DAE was allocated Rs 3351.69 crore, dwarfing, in comparison, the Rs 473.56 crore allocated to the Ministry of Non-conventional Energy Sources (MNES), which is in charge of developing solar, wind, small hydro and biomass-based power. Despite the smaller allocations, installed capacity of these sources was 4,800 MW (as compared to 3,310 MW of nuclear energy). While their contribution to actual electricity generated would be smaller since these are intermittent sources of power, they have much lower maintenance costs. Further, most of these power programmes, like wind, began in earnest only in the last decade or two, and there is ample scope for improvement. This relative lack of attention to renewable and decentralised systems of electricity generation illustrates the third point highlighted by the UK SDC.

The experience with India's nuclear programme also exemplifies the UK SDC's argument regarding the economics of nuclear power. A comparison of the costs of generating electricity from nuclear and coal-fired thermal power plants, using the standard discounted cash flow methodology, shows that nuclear power is competitive only for low discount rates (see Figure 1); for a wide range of realistic parameters it is significantly more expensive. The discount rate is a measure of the value of capital, and given multiple demands on capital for infrastructural projects, including for electricity generation, such low discount rates are not realistic. A larger proportion of nuclear capacity therefore implies that poorer sections of society cannot afford electricity, at least without greater subsidies. It also implies that there are many far cheaper ways of reducing carbon emissions.

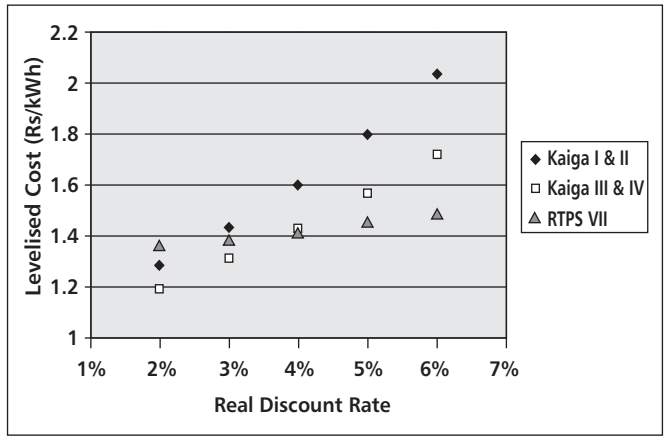

Figure 1: Levelised cost (the bare generation cost which does not include other components of electricity tariff like interest payments and transmission and distribution charges) of Kaiga I and II (operating reactors), Kaiga III and IV (reactors under construction; projected costs), and RTPS VII (operating thermal plant) as a function of real discount rate (a measure of the value of capital after taking out the effects of inflation)

The results shown in Figure 1 are based on the costs of generating electricity at the Kaiga Atomic Power Station and the Raichur Thermal Power Station (RTPS) VII — both baseload plants of similar size and vintage in Karnataka. The coal for RTPS VII is assumed to come from mines 1,400 km away. The largest component of the cost of producing electricity at nuclear reactors is the capital cost of the reactor, which includes the construction cost (Rs 1,816 crore for Kaiga I and II, and Rs 2,727 crore for Kaiga III and IV) and the cost of the initial loading of uranium fuel and heavy water used in the reactor. The corresponding capital cost in the case of RTPS VII is Rs 491 crore. (The capital costs mentioned do not include the interest during construction.)

This economic comparison is largely based on assumptions favourable to nuclear power. In particular, the calculated cost of coal-generated electricity internalises the cost of disposing flyash in an environmentally responsible fashion, but the nuclear costs do not include those of dealing with radioactive waste.

There is no credible solution to the problem of radioactive waste; the best that can be done is short-term management. The DAE treats spent nuclear fuel by reprocessing it and

segregating the waste into different categories on the basis of their radioactivity. Reprocessing also allows the separation of plutonium, which, with further treatment, can be used as fuel in breeder reactors. Reprocessing, however, is expensive. Based on a careful examination of the budgets of the DAE, we estimate that the cost of reprocessing each kilogram of spentfuel from the DAE's heavy water reactors is in the range of Rs 20,000-30,000. The Nuclear Power Corporation does not include this cost in its tariff estimates; if included, it would increase the unit cost by Rs 0.40 to 0.60.

Besides the economic cost, the waste stays radioactive for tens of thousands of years, posing a potential health and environmental hazard to thousands of future generations. This is clearly iniquitous since these generations would bear the consequences while we use the electricity generated by these reactors. Ethical dilemmas aside, no technology that generates such long-lived radioactive waste can be considered environmentally sustainable.

Further, different stages of the nuclear fuel chain release large quantities of radioactive and other toxic materials into the biosphere. Thus, the claims of nuclear energy being environment-friendly are absolutely baseless. The nuclear fuel cycle is polluting, albeit in a different way from coal power. Climate change may be a grave danger confronting us, but it should not blind us to other environmental hazards.

There is some evidence within our country of the adverse impact of such pollution. In the early-1990s, a scientific study on the health of the local population around the Rajasthan Atomic Power Station (RAPS) located at Rawatbhata near Kota observed statistically significant increases in, *inter alia*, the rates of congenital deformities, spontaneous abortions, stillbirth and one-day deaths of newborn babies, and solid tumours. Some of the data is summarised in Table 1. Similar problems have been seen in the uranium mining area of Jadugoda in Jharkhand.

Table 1: Incidents of deformities, stillbirth and abortions

Deformities	**Proximate villages**	**Distant villages**
Total population	50	14
Above 18 years	5	4
Below 18 years	45	10
Below 11 years	38	6
Below 2 years (live born)	16	3
Stillborn children and abortions in the two years prior to the survey		
With deformities	4	0
Without deformities	2	0
Abortions	27	5

Note: Proximate villages are those near the Rajasthan Atomic Power Station (RAPS)
Source: Anumukti *Volume 6, Number 5, April/May 1993*

These environmental and public health impacts result merely from routine radioactive releases from the nuclear fuel chain. Much worse could result from the catastrophic accidents that nuclear reactors and other (non-reactor) facilities are uniquely susceptible to. Chernobyl, the best-known instance of such a disaster, not only resulted in several thousand deaths but also contaminated thousands of square kilometres of land with radioactive elements like Cesium-137. Agriculture had to be suspended, over 100,000 people had to be relocated, and the economy of Belarus was devastated. In 1957, a tank containing radioactive waste from the Mayak reprocessing plant in the erstwhile Soviet Union exploded and contaminated 20,000 square kilometres. India, still a largely agriculture-dependent economy, can simply not afford the risk of such a disaster.

It is often stated that safety issues have been adequately addressed after the Chernobyl accident. However, the basic features of a nuclear reactor remain the same. It is a complex technology involving large quantities of radioactive material where events can spin out of control in a very short time. In

studying the safety of nuclear reactors and other hazardous technologies, sociologists and organisation theorists have come to the pessimistic conclusion that serious accidents are inevitable with such complex high-technology systems. The character of these systems makes accidents a 'normal' part of their operation, regardless of the intent of their operators and other authorities. In such technologies, many major accidents have seemingly insignificant origins. Because of the complexities involved, all possible accident modes cannot be predicted and operator errors are comprehensible only in hindsight. Adding redundant safety mechanisms only increases the complexity of the system allowing for unexpected interactions between sub-systems and increasing new accident modes. All of this means that there is no way to ensure that reactors and other nuclear facilities will not have major accidents.

There is an experiential basis for concern about such accidents within India. Practically all the nuclear reactors and other facilities associated with the nuclear fuel cycle operated by the DAE have witnessed accidents of varying severity. A few examples are the unexplained power surge at the Kakrapar reactor in 2004, the 1993 fire at Narora, and the collapse of the containment at Kaiga in 1994. Because of the reasons mentioned above, many of these accidents could well have become the basis for a major radioactive release.

A further source of concern is the fact that the Atomic Energy Regulatory Board (AERB), which is supposed to oversee the safe operation of all civilian nuclear facilities, is not independent of the DAE. Further, as Dr Gopalakrishnan, the former chairman of the AERB has observed, "the AERB has very few qualified staff of its own, and about 95% of the technical personnel in AERB safety committees are officials of the DAE, whose services are made available on a case-to-case basis for conducting the reviews of their own installations. The perception is that such dependency could be easily exploited by the DAE management to influence the AERB's evaluations and decisions".

To conclude, the experience of over 50 years of experimentation with nuclear power demonstrates that it cannot be considered a safe, economical, or environmentally sustainable source of electricity. It is being recognised the world over that nuclear energy neither ensures true energy security, nor addresses the issue of global warming. Despite powerful lobbies pushing for the expansion of nuclear energy due to concerns about climate change, several Western countries have decided to phase out nuclear power. The United States has not constructed a new nuclear reactor in over two decades. If current trends continue, it appears that the share of nuclear energy globally will only decline in the years to come. India, then, is attempting to swim against the tide by trying to get into nuclear power in a big way, a tragic illustration of the continued relevance of Gandhiji's warning in the epigraph, nearly 60 years after Independence.

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CDM endorsements for nuclear energy?

So far, nuclear energy has not been formally included in CDM credits. If it is, nuclear energy will get the Kyoto stamp of approval

A S PANNEERSELVAN

I HAVE BEEN ASKED to write a comprehensive analysis of the recent Indo-US nuclear agreement. I have to write a requiem for myself. I have spent my entire adult life — as a journalist, as a political commentator and as an activist — fighting the nuclear regime and advocating moves to realise a comprehensive disarmament structure that would really eliminate these weapons of mass destruction from the face of the earth.

There are four said elements in the Indo-US nuclear deal and one unsaid. The four stated positions are: India will separate its civilian programme from its military programme and subject its civilian programme to international safeguards; there will be no need for India to adhere to the nuclear non-proliferation regime; the international Nuclear Supplies Group will start supplying nuclear fuel once the separation takes place; and the deal will ensure energy security for India. The unsaid deal is that the way will be paved for India to get Clean Development Mechanism (CDM) money for its nuclear programme under Article 12 of the Kyoto Protocol.

Before addressing the question of climate change and nuclear energy, it is important to understand the mechanism of the nuclear industrial regime. The uniqueness of the nuclear regime is that it moves swifter than others. All critiques of this regime are primarily reactive. For instance, adjustments in US laws have been made in an unusually expeditious manner. Nearly seven months before President George Bush and Prime Minister Manmohan Singh signed the nuclear deal in Delhi in March 2006, on July 26, 2005, US Congress accepted the Burr Amendment, which considers nuclear energy the cleanest energy, and decided to fund nuclear energy programmes. This is a clear indication that India's nuclear programme would be subsidised by the CDM. All this in the name of a clean environment, being sensitive to climate change, and a reduction in carbon emissions.

The International Atomic Energy Agency (IAEA) is at the forefront in pushing nuclear energy as one of the best options for the CDM. It has taken on the task of explaining the role of nuclear power in achieving sustainable development in developing countries and in mitigating GHG (greenhouse gas) emissions. Three senior members of the Indian nuclear establishment — A K Nema of the Nuclear Power Corporation of India, B K Pathak of the Bhabha Atomic Research Centre and R B Grover, technical advisor to the chairman of the Indian Atomic Energy Commission — have presented the Indian case to the IAEA, which presented it at the Sixth Conference of

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