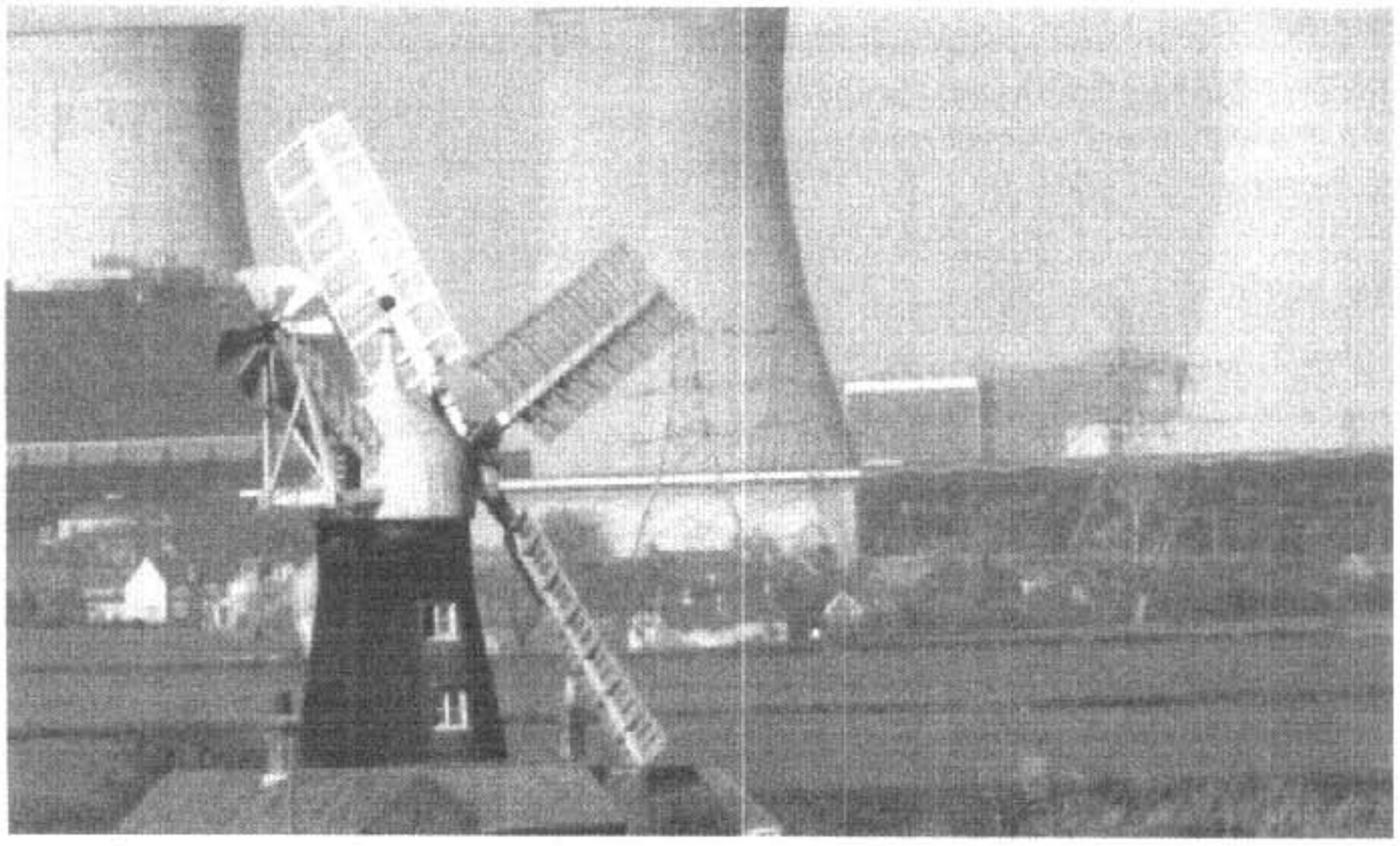
NUCLEAR POWER AND THE GREENHOUSE EFFECT

Ron Smith suggests the need for a reassessment of attitudes to nuclear power generation if world demand for electricity is to be met in future.



A nuclear power plant in Nottinghamshire, England

When the Inter-governmental Panel on Climate Change (IPCC) met in Auckland in early February this year, the group was widely reported as being 'increasingly certain' that the atmosphere was warming and that it was due to the burning of fossil fuels. Individuals at the meeting talked of dramatic changes in climate around the globe, of ice-caps melting, of large-scale inundation of low-lying land and of catastrophic consequences for human populations. Recent official publications in New Zealand have confirmed these judgments, speaking of global temperature rises of between 1 and 3.5 per cent and sea level rises of half a metre over the next century.[1]

Of course, it is accepted that there are sceptics, both in New Zealand and around the world, and that many of these are academically respectable persons. These sceptics point to inconsistencies in the data and the complex nature of the interactions that lie behind climate change. The world has had ice-ages and warm periods many times and these have been without the influence of fossil fuel combustion. Accepting that this is so, it seems very prudent nonetheless to assume that there is something in the widely-shared opinion that climatic (and other environmental) change will be the consequence of continued high levels of combustion of carbon fuels. Commenting on this point as recently as 1 March this year, the Director of the US National Climate Data Center, Thomas Karl, expressed the opinion that there was only a one in 20 chance that the high temperatures of recent years were simply unusual events, as opposed to being a turning point in global climate change.[2] About the same time, a US National Academy of Sciences report talked of 'an undoubtedly real' warming of the Earth's surface.

The problem of 'greenhouse gases' in the atmosphere does not relate exclusively to the combustion of carbon-containing fuels (coal, oil, natural gas) and the consequent production of carbon dioxide (CO_2) but this is the dominant phenomenon. Efforts to head off global climatic change have, therefore, focused on the need to reduce emissions of carbon dioxide and five other 'key' greenhouse gases. The first major steps to this end were taken at the United Nations Climate Change Conference, held in the Japanese city of Kyoto in December 1997.

The principal outcome of the conference was an agreement to limit net emissions of greenhouse gases to a ceiling based on what emissions had been in the base-line year of 1990. This was to be accomplished by the target date of 2008–10. Specific targets were set for nearly forty countries. These targets ranged from a permitted 10 per cent net increase in greenhouse emissions over 1990 levels by 2010 to an eight per cent decrease. The latter was generally the case for the United States and European countries. Australia, on the other hand, was allowed an eight per cent increase. For New Zealand the variation was zero. We are committed to reducing our emissions to what they were in 1990. Given that they are presently around 60 per cent higher than what they

There is widespread acceptance of the reality of global warming and the possibility of senous environmental consequences. It is equally widely accepted that the cause of this problem is the continuing dominant use of fossil fuels for energy production. Given an increasing demand for energy in the years ahead, the crucial question is where is this energy coming from? Various possibilities are reviewed. The conclusion is that only nuclear power offers the possibility of satisfying future demand in a way that is economic and relatively environmentally benign.

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were in 1990, this is quite an undertaking.

Noteworthy absence

It is noteworthy that most of the countries present at Kyoto came away with no target whatsoever. These include many of the largest states of the world and some of the fastest growing economies. In this group are China, India, Pakistan, Indonesia, South Korea, Taiwan and the developing world generally. The rationale for this is straightforward. The countries of the developed world progressed through the unrestrained exploitation of fossil fuels. It would be an injustice to place restrictions on those who have not yet completed their development. All the same, it does leave a gaping hole in the regulatory framework that is supposed to enable the world community to deal with the problem of potentially disastrous climatic change.

The prospect of heading off climatic change by limiting net greenhouse emissions is not improved when we look at what has happened in regard to the Protocol since 1997. The crucial step as far as states' commitment is concerned is ratification. As of February 2000, twenty-two states had done this. This is rather less than half of the number required for the Protocol to come into force (55). More particularly it is noteworthy that the list of parties that have ratified includes *not a single state* from amongst those that actually have a commitment under Kyoto. In fact for the protocol to come into force, ratifications are required from states representing at least 55 per cent of the total 1990 emissions from this group. The chances of this occurring are very small.

It is noteworthy that the New Zealand Minister for the Environment, Marian Hobbs, announced in February 2000 that the country would soon ratify the Kyoto Protocol. If this happens, New Zealand may be the first developed country to take this step and, perhaps, the only one. It will be interesting to see whether this does indeed occur and, if it does, how the New Zealand government proposes to achieve its target. As noted above, we are already very much above our ceiling figure and we have the additional complication that in New Zealand another greenhouse gas (methane) is significant.[3] On the other hand, it is clear that New Zealand's efforts in this area will be completely irrelevant to the problem of global warming. Even if we reduced our emissions to zero (not simply back to 1990 levels), we would make a difference to global emissions of only 0.1 per cent. When we already know that some of the largest, fasting growing economies in the world have no commitment to exercise any restraint at all and that, in all probability, those countries that do have a commitment will do little about it, we might wonder what the point would be. We would risk subjecting ourselves to handicap for no good end.

The Three Mile Island nuclear power station in Pennsylvania

Central problem

The problem is that the emission of greenhouse gases is central to the activities of a modern state. Coal, oil and gas are burnt to provide power for transportation, manufacturing and, generally, the satisfactions of life. As a state develops, as its GNP grows and its population increases, it demands more and more power. The World Energy Council estimates that global energy demand will double over the next twenty or so years. For some uses (for example, transportation) fossil fuels are practically indispensable.[4] In other cases, most notably electric power generation, there is a range of potential energy sources that may be exploited and some of these have negligible greenhouse emissions. All the same, if we are talking about power sources we will be utilising in the coming decade or so, it is evident that these must depend to a great degree on technologies that are already proved and plant that is already in existence or being built. The greatest potential for beginning to control the problem of the greenhouse effect is to progressively move to lower emission technologies and particularly in the area of electricity generation. The trouble is that the choices here are very limited. Figure 1 shows the present global generation pattern.

Notwithstanding the persistent claims made for solar and wind power, these sources are not likely to make a significant contribution to power generation in the decades immediately ahead. This is for a variety of reasons. To begin with they are presently financially uncompetitive. Then they are variable. You only get significant power when the sun is high and the sky is clear, or, in the case of wind, when the wind is blowing. If (or when) solar or wind generation capacity is increased, they will

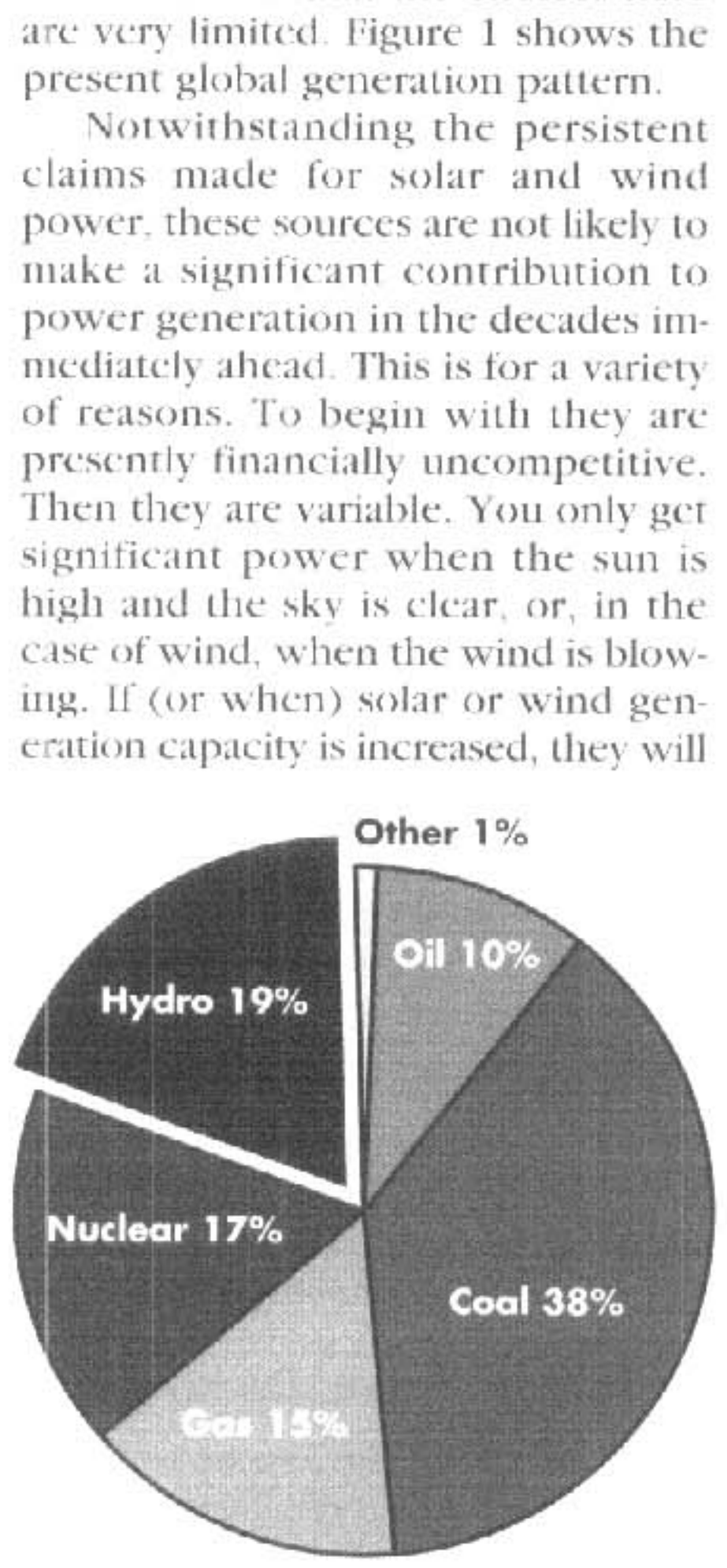

Fig 1. Global electricity sources

be seen to have major environmental disvalues. Large arrays of collectors are likely to be perceived as a substantial eyesore. For different reasons hydroelectric power will probably not make a significantly greater contribution in the future. This is partly because many of the great rivers of the world have already been dammed and there is a limit to the suitable sites and to the amount of water flowing through them. It is also because of the very substantial environmental consequences of these large hydroelectric projects.[5] The enormous 'Three Gorges' scheme in China illustrates many of these adverse effects. Looking back at Figure 1, this effectively leaves us with a choice between fossil fuel combustion and nuclear power for future power generation.

Nuclear power

At present more than thirty countries generate some proportion of their electricity by nuclear means. This is done through a little over four hundred power reactors and more are being built, particularly in North-east Asia. In France three-quarters of electricity production is from French nuclear plants. In fact, France is actually a substantial exporter of power. Between a quarter and one-third of electricity in Japan, South Korea and Taiwan also comes from nuclear power stations. But the largest nuclear power industry is in the United States. Here there are something over one hundred power reactors spread across the country. Between them they provide about 20 per cent of American electricity.

There is the potential in many of these countries to increase nuclear generation capacity. There is also the potential for countries that are not presently utilising nuclear power at all to establish a nuclear generation industry. A prime example here would be Australia. Australia has the world's largest known reserves of uranium ore, it has an appropriate technological infrastructure and it has experience in nuclear reactor operation (at Lucas Heights, near Sydney). At present it generates almost all of its electricity by burning coal (it is also a substantial exporter of coal). It could utilise nuclear power to meet at least some of its coming energy demand and thus avoid the greenhouse emissions from burning coal. Having regard to the present state of public sentiment in Australia, it may be thought unlikely to take this step.

In fact, widespread anti-nuclear sentiment is ensuring that the nuclear

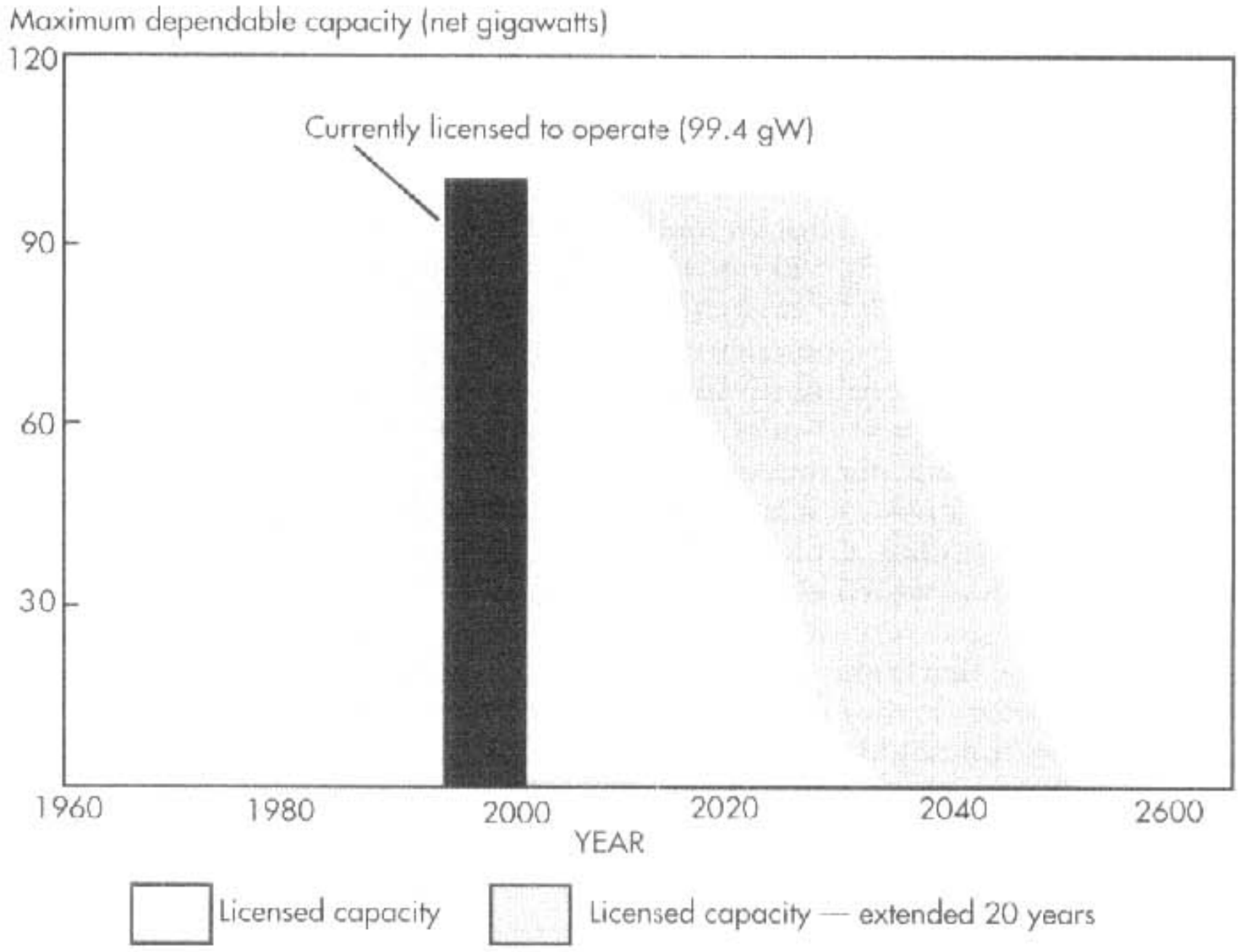

Fig 2. US Commercial Nuclear Power Reactor Generating Capacity 1960_2060

Source: *US Nuclear Regulatory Commission Information Digest* (1998)

industry is in retreat in many places in the world. Intentions to close some or all of their existing nuclear facilities have been expressed in a number of European states, including, notably, Germany and Sweden (which presently generates more than 50 per cent of its power by nuclear means). In the United States, which has a quarter of the world's power reactors, there have been no new plants built for many years. The crucial issue here is whether the existing stock will have their operating licences extended or whether they will progressively close down from 2010. If this happens (and given the apparently widespread antipathy to things nuclear, it might), United States nuclear capacity will be effectively zero by the year 2030.[6] Even if the operating licences of suitable plants are extended by twenty years (and still assuming that no new plants are built), nuclear power will be effectively extinguished by the year 2050. For the strongly anti-nuclear this might seem to be a consumation devoutly to be wished. But we need to ask again, how will this power-generation capacity be replaced? (More seriously how will the increasing demand over this period be satisfied?) The answer is almost certainly by the burning of coal or natural gas (mostly the former). This is the likely alternative in Europe, too, if its nuclear industry is progressively closed down, although in the case of Sweden there is talk of importing power from Lithuania, which has surplus capacity.[7] When this scenario is conjoined with the prospect of a rapidly-growing China continuing to supply its primary energy demands by burning coal, and the other developing states continuing to exploit fossil fuels in a completely unrestrained way, we have a situation in which we may say that effectively nothing is going to be done about the greenhouse effect.

There are undoubtedly a number of things that can be done to improve the efficiency with which electric power is generated and utilised. These range from greater use of combined-cycle gas plants (as long as natural gas supplies hold out) to encouraging the use of more energy efficient appliances and the more systematic application of heat conservation methods.

Deaths due to industrial accidents 1970–92

Oil	10,273	(in 295 accidents)
Coal	6418	(in 133 accidents)
Hydro	4015	(in 13 accidents)
Propane (LPG)	2292	(in 7 accidents)
Natural gas	1200	(in 88 accidents)
Nuclear	31	(in 1 accident)

Source: *Le Point*, 14 Nov 1998

*Now two more deaths from the criticality incident in Tokaimura (Japan) in 1999

But at the end of the day populations are increasing, and, particularly, the aspirations of these populations are increasing, and these brute facts mean there will be a steady increase in demand for power that will not be met by mere 'efficiencies'. It will not be met either by wishing into existence energy sources that have no environmental downside. There are no such sources. In this context it might be prudent to re-examine our preconceptions about nuclear power. It is important to recognise that although the range of problems which come with nuclear power are very different in kind from those that come with oil or coal or hydroelectric they are capable of evaluation and comparison. Chernobyl notwithstanding, the accident record of the civilian nuclear industry compares very favourably with that of other energy sources (see table). Even in that case, it now seems that the health consequences are not as serious as was feared. A very recent report of the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has concluded that 'there is no evidence of a major public health impact to radiation exposure fourteen years after the Chernobyl accident, apart from a high level of thyroid cancers in children, which is treatable and non-fatal'. Of course, this latter effect is not to be taken lightly, but it does need to be compared with the health effects and general environmental impact of other technologies.

Similarly, there are viable strategies for dealing with nuclear wastes[7] and the special problems of civilian nuclear power in its relation with nuclear weapons. If we are serious about the greenhouse effect and the prospect of global warming, we really ought to look seriously at these things.

NOTES

1. *Air Quality, Climate Change and the Ozone Layer* (Statistics New Zealand, Jul 1998), p.29.
2. 'Global Warming Accelerating, US Study Finds', NZPA, 24 Feb 2000.
3. Ruminant animals produce methane at both ends of their digestive process. A pick-up in our agricultural trade resulting in higher stock numbers would be a disaster for our greenhouse emissions levels.
4. Of course, as far as land transport is concerned, there is a great deal of development of non-gasoline propulsion systems, notably the hydrogen fuel cell, which would be virtually non-polluting. The big problem remains, where is the hydrogen coming from? This may be from the stripping of hydrocarbons, with the subsequent injection of waste carbon dioxide deep into the earth and away from the atmosphere. This is unproven technology. On the other hand, sourcing the hydrogen from the electrolysis of water merely brings back the question as to how we are generating the electricity.
5. For a detailed recent review of this issue see Marc Reisner, 'Unleash the rivers', *Time, Earth Day 2000* (Special Edition), Apr–May 2000, pp.66–73.
6. In fact the first US facility has now had its operating license extended by 20 years from 2005. This is Calvert Cliffs in the state of Maryland.
7. Lithuania's power comes from an old 'Chernobyl-style' reactor. The Swedish government is presently planning to close an efficient modern reactor (Barsek 1) to effectively replace its capacity by this importation. It is not a decision that has much going for it in the way of rationality.
8. See, eg, my 'Nuclear Traffic', *NZ International Review*, vol 24, no 2 (1998), or 'Nuclear Developments in Northeast Asia', in Rouben Azizian (ed), *Strategic and Economic Dynamics of Northeast Asia* (Wellington, 1999). There is also a great deal of material on the websites of the Uranium Institute of Melbourne and the International Atomic Energy Agency in Vienna.

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