NUCLEAR POWER GENERATION IN NEW ZEALAND

Submission by the New Zealand Ecological Society to the Royal Commission on Nuclear Power Generation in New Zealand

1. INTRODUCTION

1.1 Since its formation in 1951 the N.Z. Ecological Society has made numerous submissions to Governments, usually on issues directly concerned with environmental problems. The decision of the Society's Council to make this submission on the nuclear power issue, usually seen as a complex problem for engineers, chemists and nuclear scientists, is based on two concerns.

1.2 The earlier sections (1-5) of this submission outline our concern that a "yes" decision for nuclear power implies a major effort to continue meeting an ever-rising demand for power, and therefore poses major ecological threats to the New Zealand environment. These threats are implied not only by nuclear power plants, but by other energy sources as well.

1.3 The later sections (6-9) deal with a few aspects of more direct environmental concern associated with nuclear-generated electricity. Topics will be dealt with briefly, or omitted entirely. On issues such as the likelihood of major reactor accidents long-term availability of assured fuel supply, adequate containment of wastes, and the real costs of nuclear-generated power, our lack of input indicates our lack of knowledge, but not a lack of concern that these are major problems and need to be fully investigated.

2.0 THE GROWTH MYTH

2.1 *Growth in ecological systems*

Growth, and growth-related ideas, dominate our thinking and determine many of our actions. However, from an ecological perspective, growth plays a small part in the functioning of individuals, populations or biotic communities. Living things grow rapidly for only a small proportion of their existence. Populations characteristically grow slowly, pass through a short period of rapid, exponential growth, then decline in numbers or fluctuate around a mean density for an extended period of time. Since biotic communities, or ecosystems, are assemblages of populations of various plants and animals, they exhibit changes as their component populations wax or wane but do not maintain high rates of growth in materials or biomass.

2.2 *Ecological constraints on growth*

The reasons why individuals, populations, and ecosystems spend so little time in the "rapid growth" phase has been well demonstrated. Rapid growth is possible only for populations that are not constrained by limits of space, energy, nutrients, or other needed resources. High growth rates are characteristic of low density populations that are making minor demands on the local resources at the start of the rapid-growth phase. As numbers rise so do the various demands for resources, and may then be followed by depletions, shortages, and constraints on further growth. Populations may adjust too slowly to developing shortages, and by the sheer weight of numbers their demands may exceed the supply of remaining resources. Populations whose growth rates have "overshot" their resource base then crash to low numbers, or to extinction. There are no exceptions to the rule that survival for any population demands that it live within its "resource means".

2.3 *Constraints on energy demands*

We have pointed out in the two previous sections that systems dependent on material resources are eventually constrained in their growth by resource availability. Energy production, which requires input of materials as well as other energies, faces similar restrictions.

2.3.1 The depletion of resources as demands continue to rise is clearly summarised for the New Zealand situation in the paper *Energy Scenarios for New Zealamd*[1]. Even with the installation of several nuclear power plants a commitment to an energy growth rate of 3.6% per year between 1975 and 2025 led Maiden[1] to conclude:

> "The scenario research demonstrates that high economic growth, through policies described in the Continuation Scenario, will lead to New Zealand's fossil fuel reserves being virtually depleted by 2030".

Hence, even a massive commitment to nuclear power does not prolong indigenous fossil fuel supplies to any significant extent if we continue trying to meet high growth rate targets.

2.3.2 We submit that New Zealand is rapidly approaching significant resource and environmental constraints with regard to energy supplies. Traditional sources of electricity (and other energy forms) will be quickly exhausted if high growth rates in demand are met. Nuclear power is an attempt to boost the local resource base by importing fuel in the form of uranium fuel rods. As we have already pointed out (2.3.1) this approach, which is of dubious economic viability[2], does not solve the dilemma.

2.3.3 If we are to sustain New Zealand society and our environment into the next and following centuries with minimal dislocation, trauma, and environmental abuse, then the myth that ever increasing growth in energy consumption is both necessary and possible must be critically examined and effectively buried.

2.3.4 We are concerned that these ecological constraints on future energy supplies still do not appear to be influencing planners within the New Zealand Electricity Department. In a recent address[3], Mr G. B. Collie, N.Z.E.D., explained that the basis for all 'estimates of consumer requirements' has been average weather conditions and the *expected unrestricted rate of growth of the economy in the future*. There seems no evidence to justify the conclusion that "consumer requirements", as contrasted to "consumer demands", need to rise at an unrestricted rate for us to maintain adequate living conditions.

3.0 Nuclear Power: Resilience and Options

3.1 *Concept of resilience*

Recent advances in ecological theory relating to resilience and stability in ecosystems have important implications for the nuclear power decision.

3.1.1 For some time ecologists have argued that the more complex or diverse a biotic community is, then the more stable it is likely to be~. Greater diversity is also thought to confer greater resistance to adverse effects. For example, a complex, multi-species native forest is more likely to resist an insect pest than would a single-species forest of *Pinus radiata*.

3.1.2 Recently Holling[5] has argued that "resilience" is a more useful concept that better explains how stability, change, and resistance to change are linked.

Holling[5] states:

"Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist. In this definition resilience is the property of the system and persistence or probability of extinction is the result. Stability, on the other hand, is the ability of a system to return to an equilibrium state after a temporary disturbance. The more rapidly it returns, and with the least fluctuation, the more stable it is. In this definition stability is the property of the system and the degree of fluctuation around specific states the result."

3.1.3 For all species, evolution is like a game, and the only payoff is to stay in the game[6]. Hence the key point for any species, man included, is to make sure of persistence by *maintaining flexibility above all else*. Species that are flexible may still show considerable fluctuations in numbers over time, yet are able to "bounce back" in response to unpredicted, adverse, environmental changes.

3.1.4 How would we handle the problems of energy supply strategies using the "resilience approach"?

Holling[5] summarises:

"A management approach based on resilience would emphasise the need to keep options open. . . . Flowing from this would be not the presumption of sufficient knowledge, but the recognition of our ignorance; not the assumption that future events are expected, but that they will be unexpected. The resilience framework can accommodate this shift of perspective, for it does not require a precise capacity to predict the future, but only a qualitative capacity to devise systems that can absorb and accommodate future events in whatever unexpected form they may take."

3.2 *Resilience of nuclear power generation*

We argue that electricity derived from nuclear power generation is a system of low stability, low resilience, and a dangerously low capacity to absorb and accommodate unexpected future events.

3.2.1 Several factors support this conclusion.

A. *Operational mishaps*. Overseas experience has shown that minor accidents can result in plant shutdowns for months or years. The extreme complexity of nuclear technology, its *modus operandi* that *nothing must go wrong,* inevitably means a low resilience to the unexpected.

B. *Fuel supply*. Present commercial nuclear plants can operate only with fissile fuel, at present only uranium. Opting for an energy system which is dependent on a single fuel is justified only if there is strong evidence of adequate supplies being available. That this is not the case is the conclusion of a recent report jointly produced by the International Atomic Energy Agency and the Nuclear Energy Agency of the O.E.C.D.[7]. Given projected demands there is "the possibility of severe and fundamental supply problems over the long term". We feel that a nuclear commitment should not be contemplated until a firm long-term contract for fuel supply is assured.

C. *International dependence*. New Zealand would need to import not only nuclear fuel but the entire nuclear technology as well. Such a course would increase our dependence on overseas sources for our energy needs and lower our ability to cope with potential overseas disruptions to energy supplies.

D. *Economic flexibility*. Given the enormous capital costs of a single nuclear station, the availability of capital to develop other energy options could be correspondingly decreased by opting for nuclear power[2]. We consider it unwise to foreclose prematurely alternative options, given the increasing problems associated with nuclear power and the increasing promises shown by alternative energy systems.

E. *Electricity only*. Apart from the possibility of using waste hot water for heating purPoses the only energy output from a nuclear station is electricity. A far more flexible option would be to develop a range of energy sources more appropriate to the variety of end-uses for which it is needed.

F. *Unexpected future events*. A variety of unexpected future events can be envisaged, all of which would show up the low resilience and low stability of nuclear power generation and, coincidentally, show how existing energy systems would have greater resilience and greater stability to combat the same problems. They are: severe, on-site earth movements; acts of sabotage; acts of war; social collapse and instability; threats of blackmail; unanticipated problems in decommissioning plants; unresolved waste storage problems; unanticipated health and environmental effects of accidental radioactive releases.

3.3 *Resilience of alternative and existing energy systems*

Existing energy systems (hydro, geothermal, fossil fuels) are more stable (recover faster from accidents) and more resilient (can accommodate changes or be changed) than is a nuclear power system.

3.3.1 We would encourage still further diversify cation of energy systems and believe that a variety of options now under development (solar heating, heat pumps, wind-generated power, wave power bioconversion techniques) have the potential for making significant contributions to future energy needs. Such a diversity of energy resources, more directly related to end-uses, would further enhance the resilience and stability of the total energy position.

3.3.2 Such alternatives to nuclear power generation have further advantages if they reduce the dependence on imported fuels, increase local manufacturing industries, and eliminate the likelihood, however remote, of catastrophic damage to our environment and primary produce agricultures.

4.0 GENERATION VERSUS CONSERVATION OF ENERGY

4.1 *Environmental impacts of generating plants*

We recognise that in the short-term the demand for further energy supplies will increase. For reasons that are elaborated elsewhere in this submission (6.0, 7.0) we consider that nuclear power generation places the New Zealand environment at grave risk from the accidental release of radioactive material. Even the routine operation of such a power plant is likely to cause environmental disruption (8.0). At the same time we acknowledge that alternative energy sources (hydro, fossil-fuel stations, geothermal, windmills, energy farming) all involve environmental damage with varying degrees of severity .

4.1.1 For these reasons, we presented our argu ments (2.0) in favour of a significant reduction in the rate of growth of energy demands in New Zealand. Further, we believe that the amount of energy available for effective use could be substantially increased by: (a) programmes of energy conservation and (b) increasing the efficiency of energy use.

4.2 *Energy conservation*

Previous energy pricing policies have not encouraged energy conservation. We view this as an important area where positive Government action is required. Energy conservation extends the lifetime of energy reserves, as well as reducing environmental effects. An interesting example of how significant energy savings can be made with firm governmental action is presented in Appendix 1.

4.3 *Energy efficiencies*

Allied to conservation policies are the numerous ways that primary energy sources could be used more efficiently. Ample data exist from overseas to demonstrate that present energy consumption can be extremely wasteful[9,10]. Half of the energy flow in the United States (1970 figures) is lost as waste heat[9].

4.3.1 Considerable savings through increased efficiencies are possible in the industrial sector. Thus, thermally generated electricity in the United States (in 1971) resulted in 68.5 % of the output being wasted[11]. In the same year, Swedish thermal electric power plants were wasting only 47 % of the heat produced; another 24 % being used for space heating or low temperature processes[12].

4.3.2 In an extensive and thorough review article on energy utilisation Schipper[13] concludes:

". . . economic analysis of the physical options for energy conservation shows that saving 30-40% of the expected future total energy demand in the United States would be far less expensive than supplying the increased amounts of fuels and electricity dictated by naive extrapolation of historical trends. Conservation strategies also tend to increase employment and decrease pollution, while saving energy and money. By easing demands on dollar and energy capital required to build and run energy-producing facilities, conservation slows the real rise in the cost of energy. However, conservation faces a full range of important non-technical problems which are rooted in the history of energy utilisation at low energy prices, as well as barriers connected with defects in the pricing of energy, the control of the end use of energy, and the time necessary for society to adjust to sharply rising energy costs."

4.3.3 We hope that a decision to "go nuclear" will not be taken while substantial savings could still be made through energy conservation policies.

5.0 NET ENERGY CONSIDERATIONS

5.1 We are concerned that when the value of nuclear power is assessed considerable attention should be given to net energy considerations. Proponents of nuclear power should be able to demonstrate a favourable energy return for the total energy investment. Net energy can be defined as: "The energy yield in excess of the cost of input energy"[15]. For such calculations the various energy values are converted to fossil fuel (usually coal) equivalents.

5.1.1 "A net energy analysis done at the Federal Energy, Mines and Resources Ministry has shown that, given the projected growth rate of Canada's nuclear programme, the net energy returned to society by the year 2000 will be minimal."[14].

5.1.2 This statement is similar to one made by Odum[15] which reads as follows: -"When all energy used cumulatively by the Atomic Energy Commission and all other inputs to nuclear energy are calculated, one finds there has not yet been any net energy from nuclear energy. It was mainly running on fossil fuels in its early years. When one power plant was considered through its full lifetime and fuel traced through the whole energy transformation chain, Klystra and Han (1975) (Energy analysis of the U.S. nuclear power system. In "Energy models for environment, power and society," by H. T. Odum, pp. 138-200) found a 2.7 yield for one fed back, much less than the fossil fuels of oil and coal now being used. If a major accident occurs and the energy losses of the disturbed area are subtracted, a lower yield ratio results. If these estimates are correct, nuclear energy may not be the preferred energy source; less economic vitality is possible with nuclear energy than with current fossil fuels."

5.1.3 By way of contrast, geothermal steam power plants may yield 50 units to one unit that is fed back[16].

6.0 WASTE STORAGE PROBLEMS

6.1 We are concerned that serious damage might be done to ecosystems by the accidental release of radioactive materials during the operational life of a nuclear generating station. We are also concerned with the ecological implications of long-term storage and containment of radioactive waste products.

6.1.1 The risks of temporary storage of high-level wastes may be substantially reduced by the conversion of corrosive solutions to stable solids[17]. From paragraph 381 of the Flowers Report[18]:

"The delay in bringing the vitrification process into commercial production stems from a long period of inactivity in the 1960's when no further development work was carried out. It is strange in retrospect that a matter so important for the safe development of nuclear power should have been delayed for so long."

6.1.2 Although the D.S.I.R. expresses faith in the general concept that radioactive wastes can be fixed with assurance in silicate glass[19], problems such as leachability and the generation of substantial amounts of heat require careful consideration especially in respect of consideration of geological disposal sites. The question is also raised of how a New Zealand nuclear programme would utilise the vitrification process. Would New Zealand have to export wastes for solidification to an overseas commercial plant involving all the risks of spillage of radioactive waste?

6.1.3 Whatever promise the vitrification process may seem to offer, it cannot be inferred that a permanent solution to the disposal problem has yet been found. The goal must be perpetual and infallible isolation from the biosphere. The long-term implications of radioactive waste storage from an ethical perspective has been eloquently expressed by Willrich. This statement appears as Appendix 2.

6.2 *Storage in salt formations*

6.2.1 The D.S.I.R.[19] in its evidence on radioactive waste management notes that rock salt is one of the three principal types of material advocated as being suitable geologically for radioactive waste disposal. "Salt Vault", a pilot scheme for salt formation storage, which was carried out in the U.S.A. in the late 1960's near Lyons, Kansas, was dropped when doubt was cast on the alleged impermeability of the salt formation[20].

6.3 *Availability of sites*

6.3.1 One of the criteria for a geological disposal site is that it should be located in an area distant from the mobile belts of the earth, tectonically stable and without records of volcanic activity in the last few million years. Where in New Zealand can such an area be found? While the D.S.I.R.[19] states, "A geological formation selected with the above criteria would offer an extremely low risk of radionuclide release", it also admits that "it would be hard to find a suitable disposal site on land in New Zealand" and it fails to suggest where such a site may be located.

6.3.2 A Geological Society sub-committee report (pers. comm.) was more direct when it stated:

"No on-land sites are available in New Zealand suitable for ultimate disposal of high level wastes and spent fuel rods."

Given the geological history of New Zealand such problems as storage of wastes must be regarded as major concerns.

7.0 RADIOACTIVE RELEASES IN THE ENVIRONMENT

7.1 *Bioaccumulation of radionuclides*

Some overseas experience can give useful guidelines as to likely environmental effects within New Zealand of accidental radioactive releases. Nonetheless, basic research to assess fully the importance of bioaccumulation of radionuclides should be done for New Zealand ecosystems and food chains.

7.1.1 Bioaccumulation of radionuclides has now been demonstrated in a variety of aquatic environments[21, 22, 23], although a great deal remains to be learnt about the biogeochemistry of plutonium and other actinides in relation to long-term build-up, availability, and transport in the environment[31]."

7.1.2 The likelihood of bioaccumulation is greatly increased by two factors; if there is considerable biological activity of the element of the radionuclide (e.g., iron, cobalt), or if the element of the isotope is a limiting growth factor in the environment. Thus the quantity of radiation released is inadequate on its own to assess the ecological impact of accidental releases. The biological activity of the particular radionuclides involved is also important.

7.1.3 We would urge that any proposal for a nuclear power facility in New Zealand should involve adequate research at the proposed reactor site so that the potential for bioaccumulation of radionuclides can be fully assessed.

8.0 IMPACT OF THERMAL DISCHARGES IN AQUATIC ECOSYSTEMS

8.1 Nuclear power reactors generate considerably more waste heat per unit of electricity generated than do modem fossil fuel stations~, This heat may have considerable effects on the surrounding aquatic ecosystem if it is released in cooling water. The amount of heat released depends on the cooling system employed at the station. The most heat is released to an aquatic ecosystem by a "once through" condenser cooling water system which typically returns the water 8°C hotter than it was taken in[24]. Temperature differentials may be wider than this[26]. Major deleterious changes to the aquatic ecosystem can 1;>e expected if the temperature of the water body surrounding the cooling water outlet is increased by 3°C or more[27, 28, 29, 30].

9.0 Environmental Impact Reporting Procedure

9.1 The N.Z.E.D. preparation plan[24] proposes that the Environmental Impact Report on the first nuclear power station is to be prepared and audited before the specifications for the reactor system are prepared. However, an adequate E.I.R. can only be prepared after certain reactor specifications are known. The impact of thermal discharges cannot be ascertained until the nature of the cooling system is detailed. The type and quantity of radionuclides released both continually and in accident situations by the reactor type chosen must be known before the biological impact of nuclear releases can be assessed.

9.2 In our opinion the one year proposed for preparation for publication of the E.I.R. is inadequate. A full year of monitoring of the aquatic ecosystem surrounding the cooling water outflow and a further six months of analysis and preparation would be a minimal time requirement.

10.0 The Social Aspects of the Nuclear Descision

10.1 Study of the nuclear debate makes it clear that the decisions are not to be taken solely by technical and economic experts. Concern is now being voiced[25] that the managers of nuclear energy will tend to become a highly trained, remote group of technical and economic experts, making decisions for a society on technical grounds beyond the public ken. Dr Robert Mann has criticised the complete failure of the N.Z.E.D. to advocate any public participation in New Zealand's nuclear decision.

10.1.1 The Flowers Report[18] has defined the problem well. Paragraph 521 states:

> "We have explained our reasons for thinking that nuclear development raises long-term issues of unusual range and difficulty which are political and ethical, as well as technical, in character. We regard the future implications of a plutonium economy as so serious that we should not wish to become committed to this course unless it is clear that the issues have been fully appreciated and weighed; in view of their nature we believe this can be assured only in the light of wide public understanding. We are perfectly clear that there has so far been very little official consideration of these matters."

Paragraph 522 follows on:

> "The question arises of how the necessary public understanding is to be brought about Considered judgement requires the weighting of many factors; estimates of future energy needs in relation to projections of economic growth, and the environmental consequences of different energy strategies and their estimated economic and social costs. There is a need, we believe, openly and deliberately to weigh the risks and costs of embarking on a major nuclear power programme against those of not doing so."

10.1.2 We would hope that, besides the valuable mechanism of this Royal Commission, other avenues for informing and adequately involving a wider section of the public in the nuclear decision will be developed and acted upon.

11.0 In summary, this Society feels that it is unwise to proceed with nuclear power generation within the near future. Whether or not New Zealand does so in the long term, there seems much to gain and little to lose in delaying a decision now and in developing other alternatives, so giving the nuclear power industry the time to evolve safer and more efficient plants and, hopefully, solve the associated problems to which we have referred.

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APPENDIX 1

An example of significant energy saving through an energy conservation programme.

"As a result of an accident of contracting, virtually all the oil to produce electricity for the Los Angeles Department of Water and Power was affected by the Arab oil embargo in 1974. Los Angeles responded by developing a precise and strong program for achieving energy conservation. Just before Christmas 1973 the City of Los Angeles told merchants and building managers that they would have to cut their electricity consumption by 20%. Within four days consumption dropped 11 %, and by the end of the first week it was down 14%. During the first two months of the program, average electricity consumption was reduced 17 % below the corresponding months of the year before; commercial sector usage in Los Angeles dropped almost 30%. These figures compare with a less than 5 % reduction in total energy use for the rest of the United States.

The Los Angeles plan specified reductions in energy relative to a base period. Quotas were assigned to individual customers. Sanctions for failure to comply with the quotas were stiff. The penalty for using more electricity than permitted during the first billing period was a surcharge of 50 % of the entire bill; the second violation called for a two-day power shutoff; a third violation called for a five-day shutoff. The Rand Corporation surveyed Los Angeles to determine the kinds of procedures that had been used to conserve electricity. A typical procedure in an office building that reduced energy electricity use in excess of 40% included the following: removing half of the fluorescent lighting tubes; extinguishing 75% of the lights in indoor parking facilities; turning off many exterior lighted signs; running the main plant air conditioning system less frequently; reducing the winter thermostat from 75° to 70°F; removing one of three elevators from service except during peak rush periods. Reduction of lighting load was a major factor throughout the city. This not only decreased the direct load for producing light, but also reduced the load upon the air conditioning system. A computer facility achieved a 23 % cutback in its total energy use as a result of decreasing the number of lights in the rooms in which the computer facility was located. The major factor in the Los Angeles plan was that the importance of the problem and the severity of he penalties made almost everyone concerned with energy use aware of the problem. Consequently, there was improvement in maintenance and thermal load management in many cases. "

SOURCE

CRAIG, P. P.; DARMSTADTER, J.; RATTIEN, S. 1976. Social and institutional factors in energy conservation. *Annual Review of Energy* 1: 535-551.

APPENDIX 2

Implications of containing long-lived radioactive wastes.

"The time dimension of the problem of radioactive-waste management is at least as troublesome as the spatial dimension. Depending on the characteristics of the waste involved and the disposal technique adopted, radioactive material may be a lethal hazard for hundreds, or thousands, or hundreds of thousands of years. Lethality for only a few hundred years would exceed the expected lifetime of all governments and many nations. Lethality for thousands of years would transcend civilisations, and hundreds of thousands of years may reach into a different geological era. Governments and private industries using nuclear power thus assume that radioactive wastes are effectively isolated from the biosphere and do not somehow find their way back to poison life."

SOURCE

WILLRICH, M. 1976. International energy issues and options. *Annual Review of Energy* 1: