Nuclear Renaissance Requires Nuclear Enlightenment

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Abstract

Nuclear energy was developed by technocratic elites during the Cold War and as a consequence is regarded by many as an authoritarian technology. This paper explores this history, but asks whether, as pressures grow for profound changes in energy use as a result of global anthropogenic climate change, nuclear power might actually represent a means to preserve our liberal society. If, in the absence of nuclear energy, aggressive constraints on consumer energy use are mandated in order to achieve climate stabilisation, then there are risks of increased social disorder as concerned minorities organise themselves to oppose measures that they regard as green authoritarianism.

Thus far policy for nuclear power has been dominated by a technocratic intent to minimise safety risk in the objective statistical sense. More important, however, for the future politics of nuclear power will be public perceptions of risk and public preferences as to who should bear such risks. This paper argues that it is proper to do more to minimise public fears concerning nuclear power. Such actions must confront the reality that nuclear power, as conventionally deployed, is extremely well matched to public fright factors. While nuclear power is not especially dangerous - it is especially frightening.

Various international approaches to nuclear energy policy are considered. This paper argues that, although there are relevant national constitutional and historical factors, those countries adopting more local consensus-based approaches are more likely to achieve enduring policy success. Such an approach would allow for a *nuclear renaissance* founded upon principles of *nuclear enlightenment*.

Keywords: Agent Based Simulation, Distributed Electricity Generation, Technology Adoption, Complexity Science

Introduction

Currently many western governments are actively considering the future of nuclear power. This author has recently published a book entitled *Nuclear Renaissance – technologies and policies for the future of nuclear power* (Nuttall, 2005a). The book explores the various multifaceted policy issues that are leading to renewed interest in nuclear electricity generation in Europe and North America. These issues include the good greenhouse gas credentials of nuclear power, the beneficial attributes of nuclear energy vis-à-vis energy security and the recent improvements in nuclear electricity economics. Despite these favourable attributes, nuclear power cannot yet be regarded as sustainable in a formal sense. Rothwell and van der Zwann have examined the sustainability of current light water (LWR) reactor systems in some detail and they conclude that while LWR systems are consistent with the intermediate form of sustainability over the foreseeable future when one considers environmental externalities and social externalities associated with health and safety, they fail in respect of non-renewable resource depletion, a lack of effective institutions to restrict proliferation and the capital-intensive economics of new build (Rothwell, 2003). The failings identified by Rothwell and van der Zwann might be overcome in time as new nuclear reactor technologies are deployed, novel (e.g. thorium-based) fuel cycles are developed and financial and regulatory structures improve. Rothwell and van der Zwann, neglect however to consider one of the greatest challenges to the social sustainability of nuclear power – social acceptance.

Gordon MacKerron has suggested that nuclear power must become 'ordinary' if it is to find an enduring role in western electricity systems (MacKerron, 2004). One important aspect of the lack of ordinariness in nuclear power is unalterable – its historical association with the development of nuclear weapons and the Cold War. The synergies between nuclear weapons development, naval propulsion systems and commercial nuclear power are powerful and undeniable. In fact it is the synergy between naval propulsion and the successful emergence of light water reactors that is most important in the history of nuclear electricity. In many ways this history is paralleled by the synergy between the development of Gas Turbine technology for electricity generation and military aerospace research and development into jet engines. As for the link between nuclear weapons and nuclear power; for the countries with permanent seats on the United Nations Security Council nuclear weapons development predated the development of nuclear energy systems. It is arguable that some later members of the nuclear club, such as India and Pakistan developed nuclear weapons programmes as an offshoot of their civil nuclear energy projects. These states used a nuclear energy infrastructure and knowledge base to assist with the separation of plutonium and the enrichment of uranium to provide materials for fission weapons. It is incorrect, however, to regard such weapons developments as an inevitable consequence of nuclear energy programmes. For instance, neither of the key sensitive nuclear materials: Highly Enriched Uranium (HEU) nor separated plutonium, are required for the operation of

a commercial nuclear power programme. Global moves towards a nuclear renaissance, such as might be required to militate against the global threat of anthropogenic climate change would appear to require increased internationalism and globalization. Michael May and Tom Isaacs have argued forcefully in such terms for a strengthening of global non-proliferation measures (May, 2004). While the bottom up emergence of local initiatives is a possible route to sustainability, indeed it is the dominant paradigm for renewables, the proliferation risks of nuclear power imply that the nuclear approach to a low carbon future must be via a large-scale internationalist approach if proliferation and terrorism risks are to be minimised. This leads us to recognise that public attitudes to centralised authority versus decentralised decision-making are central to the future of nuclear power. Malcolm Grimston has touched upon these issues when he argues that a key difficulty of nuclear power is that it is poorly matched to modern preferences for local, or even individual, control (Nuttall, 2005a p.78). In extremis such a thesis posits that it is not cost, safety or environmental performance that is key to public attitudes to energy options, but rather the nature of the individual's control of technology. A micro turbine or Stirling engine in one's kitchen fits the *Zeitgeist* better than a nuclear power station in the next county. These possible aspects of public acceptance need to be tested carefully in future public attitudes work.

Does Nuclear Fission Lead to Technocracy?

The relationship between nuclear power and public attitudes prompts the more general question posed by Langdon Winner: 'do artefacts have politics?' and the particularly challenging and stronger question 'do technologies shape or determine political action?' (Winner, 1986). In his book *The Whale and the Reactor*, Winner challenges the prevailing orthodoxy that holds that it is absurd to attribute political power to technologies assembled by man from raw and inanimate materials. Indeed this prevailing attitude implies a world-view that technology is socially constructed rather than society itself is technologically constructed. Winner argues that not only do artefacts have political consequences but that certain technologies do indeed imply forms of social and political organisation. Winner gets to the nub of our concerns when he quotes Jerry Mander:

> *'if you accept nuclear power plants, you also accept a techno-scientific industrial-military elite. Without these people in charge, you could not have nuclear power'* (Winner, 1986).

In this paper we tend to the conclusion that technologies can prompt a need for new political and social decisions but contest the view that the outcomes of such deliberations are in any way inevitable or pre-determined. Therefore we ask: is it possible to have a nuclear power industry that is not governed by Jerry Mander's techno-scientific industrial-military elites? Might we construct a nuclear power system that exists only at the pleasure of the people and which is shaped by their concerns?

Winner posits that because uranium is a finite resource commercial nuclear power will inevitably move to a plutonium economy. Over the long term proliferation will be inevitable and to militate against such risks society must move to an Orwellian surveillance state. These concerns and the 'Atomic Priesthood' concept developed by Thomas Sebeok[1] imply a surveillance society separating a technocratic nuclear elite from an ordinary population living in ignorance of such matters. Winner argues that attempts to boost public acceptance of nuclear power cannot yield protection against the drift to the plutonium surveillance state. He argues:

> *Yes, we may be able to manage some of the "risks" to public health and safety that nuclear power brings. But as society adapts to the more dangerous and apparently indelible features of nuclear power, what will be the long-term toll in human freedom?* (Winner, 1986)

Whether the presence of separated fissile materials will yield the totalitarianism feared by Winner or simply require stronger international oversight as proposed by May and Isaacs is partly a matter of individual political perception. What is clear is that the notion that nuclear power risks eroding democracy, privacy and individual liberty is well established. A particularly pessimistic vision forms the basis of Robert Jungk's book *The Nuclear State* (Jungk, 1979). He asserts that nuclear power represents a fundamental tipping point in the evolution of human society. He warned in 1979:

> *The totalitarian technocratic future has already begun. Chances of preventing it still exist, but time is short. A peculiarity of atomic development stems from the fact that it can be arrested only up to a point of no-return. Once that point is reached it is impossible to stop. This 'irreversibility' is an entirely new phenomenon in history… When the number of installations and waste disposal units has passed a certain stage, the necessity for strict surveillance and control will leave their mark permanently on the political climate.* (Jungk, 1979 p. xiii)

Robert Jungk was a prominent futurist and opponent of authoritarianism. It is interesting to note the special attention that he gave to nuclear matters during his career. He died in 1993 and so now is unable to advise us as to whether society has indeed reached its *point of no return*.

The warnings of Winner, Jungk and others are important at a substantive level as they refer to the future of our liberal societies. It is not the purpose of this paper to seek to assess whether they will be proved right, rather we raise these issues as they form an important part of legitimate public concern regarding nuclear power. As we have seen, several prominent thinkers have argued that nuclear power erodes freedom, however the converse view is also worthy of consideration. Perhaps nuclear power may even have a positive role in preserving liberal society. If the thoughtful public is concerned that

[1] In 1984 linguist Thomas A Sebeok was tasked by the US office of Nuclear Waste Isolation to find a way in which to convey a warning message about the dangers of a nuclear waste repository in a way that would be resilient for 10,000 years or 300 generations. Sebeok concluded that over such long periods both languages and the contexts of languages vanish. His controversial suggestion was the construction of an 'Atomic Priesthood' capable of sustaining the truth from generation to generation and positioned to warn intruders of the dangers of any curiosity.

energy and environment policy has the potential to alter society, then perhaps there is a benefit in the public being encouraged to ask where the greatest threats to liberalism really lie. The threat of the plutonium society has now been well articulated for several decades. In recent years the public has learned to consider the impacts on our society that will arise from anthropogenic climate change. This may have profound importance for the public acceptance of nuclear power.

Nuclear power is an almost zero greenhouse gas electricity source contributing roughly 16% of global electricity (Hore-Lacy,2003). The UK Royal Commission on Environmental Pollution stressed the importance of carbon dioxide emissions reduction when in 2000 it noted:

> *For the UK, an international agreement along these lines which prevented carbon dioxide concentrations in the atmosphere from exceeding 550 ppmv and achieved convergence by 2050 could imply a reduction of 60% from current annual carbon dioxide emissions by 2050 and perhaps of 80% by 2100. These are massive changes. But the government should implement short, medium and long term strategies which are sufficiently coherent and effective to achieve these reductions.*

Any measures to achieve 60% carbon dioxide reductions (including those relying on nuclear power or the other currently contentious technology: carbon capture and storage, CCS) will inevitably have societal consequences. For instance, in order to achieve such drastic CO_2 reductions the changes to transport and mobility must be substantial. How will society constrain the behaviours of both motorists and the transport industry in order to deliver the changes required? Without the deployment of the contentious technologies of nuclear power and CCS the required reductions in carbon dioxide emissions would appear to be more expensive (Marsh, 2003 and DTI, 2003). It is not the purpose of this paper to tackle the tricky economics of nuclear power or of carbon capture and storage[2]. Rather we wish to assess whether achieving a 60% CO_2 reduction without CCS and nuclear power would necessitate uncomfortable lifestyle changes affecting many of the more enjoyable experiences of modern life. If the measures to achieve climate stability are draconian then the kick in the small of your back when you hit the accelerator in your car could in future become a distant memory as vehicle design alters to improve efficiency and eliminate wasteful excess torque. Also air conditioning could return to being a rare luxury in the UK. Many people could object to being forced to pay for mitigation services, such as CCS which represent a new cost in the system, which they do not desire and for which they cannot see a direct need. It is issues of this type that have the potential to arouse public anger and to alter public attitudes to nuclear power. The growth of fly-tipping in the UK in recent years (following moves to extract fees for waste disposal) could be an example of the kinds of societal

[2] Readers with an interest in the economics of nuclear power are recommended to consult the 2003 MIT report *Future of Nuclear Power* or University of Chicago report of August 2004, *The Economic Future of Nuclear Power.*

tensions that can result from aggressive moves in environmental policy. In this case it is arguable that problems arose despite the fact that the majority can be expected to support the policy. It is precisely when the will of the majority is perceived to be attacking the rights and privileges of a minority that the strongest political tensions can occur. While there is clearly no perceived right to fly-tip, and there is little or no majority sympathy with such illegal minority behaviour, there is clearly much frustration around the issue, both with the fly-tippers and for those saddened by the damage to the countryside. Another example of potential relevance is that in the UK there is a minority opinion that individuals have the right to hunt foxes with hounds. The recent anger of this minority at the perceived loss of a key part of their way of life (as a result of the Hunting Act 2004) is both powerful and visible. If measures to achieve 60% carbon dioxide reductions are advanced without a return to nuclear power and without the development of carbon capture and storage then there would appear to be an enhanced risk that draconian and politically unpleasant policies might be required to stabilise the climate. It is perhaps not unimaginable that in the future lovers of classic twentieth century sports cars might unite with those with an affection for a traditional coal fire, or for air conditioning, and find common cause to oppose the green authoritarians[3]. It is not impossible to imagine an energy policy backlash not unlike the emergence of the pro-fox hunting group the Countryside Alliance. In fact one might argue that a related backlash has already occurred in continental Europe and the UK with the fuel price protests of late 2000[4]. Earlier we posited the idea that public nervousness with nuclear power might be related to a perceived fear that nuclear power represents a threat to liberal society. As the threat of climate change looms ever larger there is perhaps the possibility that public attitudes might swing in favour of nuclear power in an attempt to avoid the prospect of even more authoritarian policies. If the future of nuclear power does rest upon a balance of such fears it is clearly in the interests of the nuclear industry to move away from traditional technocratic approaches. It would appear possible to develop scenarios for nuclear power that allow it to help reconcile energy policy with continued liberal democracy while simultaneously assisting the world to reduce drastically its carbon emissions.

A New Paradigm for Nuclear Power?

This paper considers the possibility that the nuclear power industry might move towards democratic multi-stakeholder processes and decision-making. In such a future the details of the industry itself must adjust substantially from those developed over the last sixty years under a technocratic paradigm. In order to appreciate the issues underpinning such shifts it is necessary to consider in some detail issues of risk and the public perception of risk.

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[3] There are parallels with the debate over 'eco-imperialism' concerning the relationship between first world environmental non governmental organisations and developing countries. See, for instance, Paul K. Driessen's controversial book *Eco-Imperalism, Green Power Black Death*, (Driessen, 2003).

[4] See http://news.bbc.co.uk/1/hi/uk/924574.stm - Accessed June 2005

Michael Mehta argues that in order to make progress on technology and risk we must first consider risk to be a socially constructed concept (Mehta,2005). This author would not go so far, but rather would argue that there are two distinct concepts to be considered. First there is true 'risk' – ideally an objective quantitative reality and often interpreted via mathematical models and constructs. Various definitions of 'risk' are used in the literature, but each relies on probability and quantitative assessment. Our intention here is to consider a separate concern - the human response to risk. This response or attitude is indeed a social construct. Of risk and risk perception, it is the former that has thus far dominated technocratic decision making in nuclear power, but it is the latter that will, and should, more strongly determine the shape of any nuclear renaissance.

Nuclear energy is not the only technology and policy issue that is likely to be shaped more by public perceptions of risks than by considerations of risk itself. One clear example is the case of genetically modified crops in Europe. Those deploying GM technologies, or for that matter nanotechnology, may have much to learn from the nuclear energy experience.

This author has argued previously that for fifty years the nuclear industry has heard that the public is scared of the dangers of nuclear power and in response the nuclear industry has worked to minimise the dangers (Nuttall,2005a). A radical shift from technocratic leadership to more democratic processes would not now be so pressing an issue if the industry had worked from the start to minimise fear as hard as it has worked to minimise danger. If the nuclear industry is to find a future associated with lower levels of public fear then it must first better appreciate the sources of such anxiety. Such thinking takes the industry firmly into the domain of socially constructed public perceptions and away from the world of quantitative or ‘true’ risk.

Peter M. Sandman has provided numerous provocative insights into these matters through his suggestion that for practical purposes *risk equals hazard plus outrage*. Hazard corresponds to ‘true risk’ as described above, while ‘outrage’ refers to the social response (fear, anger etc.) (Sandman, 1993). In Sandman’s terms therefore this paper argues that, in the case of nuclear power, the industry should have done more to recognise, understand and address the outrage rather than simply focussing upon minimizing the hazard.

In a paper examining issues facing those planning to engage in public communication about risk Jill Meara reports on a British Department of Health study on the fright factors for risk (Meara,2002).

Presenting a list similar to one used by Sandman, Meara notes that risks are less acceptable and more feared if they are perceived to be:

- *Involuntary*
- *Inequitably distributed in society*
- *Inescapable*
- *Coming from an unfamiliar or novel source*
- *Causing hidden or irreversible damage particularly dangerous to children or future generations*
- *Causing dreaded illnesses (e.g. cancer)*
- *Poorly understood by science*
- *The subject of contradictory statements from scientists in authority*

Nuclear power is remarkable in that it exhibits, or is perceived to exhibit, all of the fear factors listed above. However, it is possible to conceive of a nuclear power system designed to reduce the impact of some of the fear factors listed. In the UK these fear factors have traditionally had little or no influence on policy for nuclear energy.

In his remarkable book *Nuclear Fear - a history of images* Spencer Weart posits that nuclear power was frightening even before it existed. That is, the characteristics of nuclear fear existed prior to the development of nuclear power. (Weart,1988). Nuclear power has links to invisible death rays, mutation, and conceptions of hell. In this spirit this author is struck by the powerful iconography of Pieter Brueghel the younger's painting *The Triumph of Death* of 1562 (figure 1). At the heart of the painting is a cubic structure spewing forth fire and destruction. Surrounding this 'core' lie numerous pail and sickly bodies. These unfortunates have suffered at the hands of an army of warrior skeletons (arguably the human skeleton itself only being familiar to modern audiences because of the development of X-rays and other medical uses of radiation). In addition there are numerous pallid corpses seemingly killed at a distance by an invisible radiation like flux that leaves no visible wounds. The landscape is denuded and sterile and the few survivors either flee or are herded into a semi-underground shelter, or perhaps a prison? Various links to militarism and conflict occur at the margins of the painting. Perhaps better than any other piece of art this painting summarises the iconic reasons why nuclear power is intrinsically frightening.

Figure 1 Pieter Brueghel the younger, *The Triumph of Death (detail) c. 1562 Museo del Prado, Madrid.* In this detail the burning core of the painting is shown on the left while the survivors flee and are herded into the structure to the right.

National Differences in the Politics of Nuclear Energy

The country that has experienced the most incendiary nuclear energy politics is Germany. It is interesting to speculate that this tension is a direct consequence of Germany's totalitarian past and its front line role during the Cold War. Werner von Lensa has characterised the German nuclear energy policy experience as a 'quasi-religious war' suffering unduly from a polarised and dualistic approach to the issues (von Lensa, 1998).

With these considerations in mind it is helpful to consider Scandinavian developments in the nuclear fuel cycle. Among the older professionals in the European nuclear industry Sweden is still thought of as a country where policy for nuclear power became derailed by misplaced environmentalism in the 1970s. In fact the nuclear power sector in Sweden functions well to this day. While Sweden has just shut down its oldest nuclear power plant (Barseback-2) a programme of modernisation and capacity improvement at its other nuclear power plants will ensure that, in the short term at least, nuclear electricity generation in Sweden will increase[5]. The Swedish progressive thinking of the 1970s has however led to a remarkably positive current position for nuclear power in that country. First Sweden

[5] See http://msnbc.msn.com/id/8058171/ - accessed June 2005

took a clear decision against reprocessing on the grounds that it did not want an inventory of separated civil plutonium. Given the enduringly low price of uranium and the growing concerns for nuclear safeguards and security measures, Sweden's plutonium decision appears to have been the right one. As such the nuclear waste inventory in Sweden consists of spent fuel. Another remarkably prescient decision was that the spent fuel should be stored in a specially designed facility known as the CLAB built many metres underground in excavated granite caverns (Wikstrom, 1998). This approach differs from practice in several other European countries where similar materials are stored in surface facilities. Following the terrorist attacks on the United States on 11 September 2001 the Swedish decision to store spent nuclear fuel underground seems to have been wise. Lastly the Swedes and the Finns have been making good progress towards the very long-term management of waste spent fuel. Sweden has constructed an underground rock laboratory at Åspo near Oskarshamn. The successful completion of this facility contrasts remarkably with the 1997 failure of Nirex in the UK to receive planning permission for a similar facility known as the Rock Characterisation Facility. In the context of this paper, however, perhaps the most important aspect of the Åspo facility is its surface architecture. In marked contrast to nuclear facilities, such as Areva's La Hague reprocessing facility near Cherbourg, France with its brutal box-like buildings and its spiky antennas and towers, the Swedish Åspo facility is reminiscent of a quaint Scandinavian building in a nautical tradition (note the widow’s walk) and also with a slightly agricultural impression (see figure 2). The architecture appears to have been determined by a conscious attempt to minimise fear through familiarity and positive association in an area with proud heritage in both fishing and farming. Some technocrats might regard this approach as including an unethical attempt to deceive. To this author's impression however such arguments merely reveal a lack of understanding of the history of architecture. Over the centuries each new structural function has looked to antecedents for architectural inspiration. Many of the first mills and factories of the British Industrial Revolution of the late eighteenth century were constructed with forms reminiscent of Palladian classical architecture. In such a spirit there would appear to be nothing deceptive or dishonest in the surface structures of the Åspo facility being constructed to look like other buildings characteristic of the local landscape.

Figure 2 Surface buildings of the SKB Åspo Underground Rock Laboratory for radioactive waste management research near Oskarshamn Sweden (Source: SKB)

Towards Transparency and Inclusion

Across the Baltic Sea other moves towards the democratisation of nuclear power have been occurring. For instance, Finland was the first country in Europe to announce new nuclear power-plant construction and in so doing forms the vanguard of the nuclear renaissance. Finland also finds itself in a leading position in respect of policy for radioactive waste management. From 1983 to the present Finland has made steady progress towards the construction of a repository at Olkiluoto (Nuttall,2005). Finnish progress has been made on the basis of community volunteerism, transparency and mutual engagement between the local community and policy makers. Trust is key to the Finnish model with the nuclear waste policy makers trusting the local community by providing them with a community veto throughout the lengthy process and a reciprocal trust by the community of the policy makers that the facility is indeed as safe as it has been described. It is arguable that such processes of joint community and expert decision making works best in a Scandinavian cultural and societal setting. Given the 1997 collapse of the plans by Nirex for the Rock Characterisation Facility (RCF) at Sellafield in Cumbria. It would appear that the Scandinavian approach is now worth trying in the UK. Malcolm Grimston and Peter Beck have described the original Nirex strategy with its stakeholder communication placed towards the end of the process as having been one of 'Decide, Announce, Defend and Abandon' (Grimston & Beck,2002). In the UK and since the election of the Labour government in 1997 there have been significant moves in the UK towards more democratic processes

for policy developments in radioactive waste management. For instance a new semi-expert policy development body has been constituted: the Committee on Radioactive Waste Management (CoRWM). It attempts to operate in a transparent way and to be receptive to novel thinking. Recently CoRWM has suffered from tensions arising from its requirement to balance sociological concerns with more traditional technical matters[6]. Transparency is a concept underpinning CoRWM's work and it is also a lesson learned by Nirex following the failure of the RCF. In August 2002 Nirex published a transparency policy learning lessons from the RCF experience (Nirex,2002).

Some items of confidential information from the past, however, remained confidential after the launch of the transparency policy in August 2002. In particular the matter of greatest concern has been the secret list of ten sites considered by Nirex for intermediate level waste disposal in its (now completely ended) original research programme. The reason given previously for retaining secrecy of this information has been that it would cause blight on properties known to be near these sites. The process leading to that site list is, however, now completely ended and it seems likely that the old site list is of no future relevance for radioactive waste policy which is starting from scratch in the UK. For that reason Nirex agreed in 2005 to release the information under the terms of the UK Freedom of Information Act [7]

Originally constituted as a creature of the nuclear industry, Nirex reported in 2005[8]:

> *Nirex has this year (1 April 2005) been made independent of the nuclear industry, in a move that will boost transparency and accountability in the long-term management of radioactive waste. Independence for Nirex means that the company, set up in 1982 to implement a strategy for the safe disposal of wastes of low and intermediate-level radioactivity, can take the first step towards making a real and legitimate contribution to the Government's objective of implementing a long-term strategy for managing radioactive waste.*

Thus far we have advanced the idea of a more democratic nuclear energy system by stressing the importance of local community support. Recent United States experience in radioactive waste policy reminds us of another model for 'democratic' decision-making - publicly endorsed strong central leadership (Grimston, 2005). Since the events of September 11, 2001 the United States Federal Government has pushed forward policy for a national permanent waste repository at Yucca Mountain in Nevada. These measures, however, are being hotly contested by the state of Nevada through the courts and it is not yet certain whether the United States Government's use of strong Federal authority,

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[6] See for instance: http://www.timesonline.co.uk/article/0,,2-1638937,00.html Accessed June 2005

[7] See: http://www.nirex.co.uk/index/inews.htm Accessed June 2005

[8] Source Nirex website: http://www.nirex.co.uk/index/iabout.htm Accessed June 2005

backed by national democratic mandate will prevail. The Finnish experience of the politics of consensus would appear to be more successful model for policy progress than the US model of national democratic structures overriding the will of local people. There are numerous differences between the United States, Finland and the UK and any, or all, of them might limit the transferability of approaches between countries. For instance the countries differ in their constitutions with differing levels of central authority, they differ in geographical size and population, they differ in the level of social homogeneity and cohesion and, of course, they have different historical legacies. Nevertheless, given the failure of more domestic approaches it would appear timely for the UK, in particular, to seek to learn from international experience.

Publicly Accepted and Safe Enough

So far in this paper we have argued that nuclear power can and must become ordinary and that the decisions driving the future of the industry should be shaped by the opinions of the widest possible community of local stakeholders. It is worth policy-makers examining the possibility that such democratic processes would indeed yield a more sustainable commercial nuclear power industry. Possible measures consistent with lower public anxiety and greater public consensus include the monitored retrievability of nuclear wastes in deep underground repositories rather than the originally more orthodox, and marginally safer, approach of deep underground disposal with the facility closed with a backfill of bentonite[9] clay or concrete. Such an approach would increase the chance of public acceptance at the price of a small, but acceptable, erosion of safety. Here it is argued that if the preferred approach of the public is safe enough, then it should be adopted. Not all technologies are safe enough however. Some technologies, such as the disposal of radioactive wastes in outer space, while receiving relatively high levels of public interest, are regarded by most experts as being unacceptably dangerous[10]. The option of firing radioactive wastes into space must be rejected as it is simply not 'safe enough'. Together with others this author has written previously in support of greater levels of investigation into the partitioning and transmutation of radioactive wastes[11] (Nuttall, 2005b). It would appear that such approaches are particularly interesting as they exhibit relatively high levels of public support combined with relatively high levels of expert concern as to safety. It is important to note that in respect to more democratic nuclear fuel cycles, concern for the environment and for safety may actually reside more strongly with the experts than with the public. It would be an unusual situation for nuclear power if its safety became one of those areas of technology policy where the more you know

[9] Some backfill strategies involving bentonite clay are in principle retrievable, but would require significant effort.

[10] The use of plutonium-fuelled radioisotope thermoelectric generators on spacecraft such as the Cassini probe notwithstanding (see: http://www.seds.org/spaceviews/cassini/rtgpages.html accessed March 2006)

[11] Partitioning is the separation of radioactive waste into chemically more homogeneous streams. Transmutation is the use of nuclear physics techniques to convert harmful radioactive isotopes into shorter lived or more benign material.

the more you worry. In a move to a more democratic nuclear fuel cycles there are risks of such a situation developing and therefore experts must always be vigilant that their industry is indeed safe enough.

This author has argued previously that the nuclear industry's extreme safety culture, in which the lives of nuclear workers are to be protected as a first priority, can actually erode public sympathy (Nuttall, 2005a). For reasons discussed earlier the public are actually quite accepting of informed and appropriately remunerated nuclear workers risking their lives in an industrial setting. Similar social contracts exist in many industries such as fossil fuel extraction and civil engineering. What the public particularly resents is an imposed risk falling on relatively ignorant members of the public. Clearly, when it comes to the politics of deploying hazardous technologies, not all deaths are equal. The rational nuclear industry view that the deaths of 'real people' are more important than an equal number of deaths of unknown and unknowable people in the distant future, runs somewhat counter to public perceptions of these issues. The technocratic view is that the known deaths of identifiable workers are clearly preventable and as much as possible must be done to minimise such events. The vanishingly remote risks to large numbers of current and future members of the public simply cannot be handled in the same way. All must be done to reduce those risks, but it is not done via the same procedures as worker safety. Such disconnects between the treatment of worker safety and public risks can be a source of public concern. Policy progress can be made, but the nuclear industry must be careful to avoid the perception that it protects its own above all else. A move from technocracy to democracy can only help in this regard.

When the technocrats of the nuclear fuel cycle turn their attentions to other stakeholders they still often take the view that education is the key to greater public acceptance. Their reasoning is such that they believe that if only the public could come to know what they know, then the public too would share the expert perspective and agree with the expert conclusions. This view is known as the 'deficit model' and it is widely acknowledged to be flawed. Sandman critiques it well in chapter 3 of *Responding to Community Outrage*. He argues that while it is necessary to minimise the hazard and importantly to explain the hazard to concerned publics, such measures are usually insufficient in the absence of separate efforts to minimise the outrage. Both effective communication and real risk minimisation must go hand in hand. He states it even more straightforwardly when he says: 'Risk communication that is deployed as a substitute for risk reduction is doomed to fail and rightly so.'

One's attitude to power and control is a fundamental emotional and political thought and, as such, it would be foolish to assume that such social attributes of the individual are easily altered by education. Neither the public nor nuclear industry professionals are exempt from these realities. It would appear, therefore, that the best strategy for the nuclear industry is not to educate the public into membership of

the technocracy, but rather for the technocrats to listen to and to be more led by the public. In so doing they might seek to become truly ordinary members of the polity. Such thinking leads us to the domain of Brian Wynne and other proponents of the *contextualist* perspective on public attitudes to science and technology. Wynne stresses that science itself is socially negotiated (Irwin, 2004). This paper has argued that nuclear energy has had low levels of such social contextualisation. This would allow any nuclear renaissance be built upon more democratic foundations. The paper has noted that true probabilistic risk is not a social construct. Furthermore, it is important to note that the use of nuclear fission to generate electricity is clearly not simply a social construct. This author is reminded of the late Keith Pavitt's resonant aphorism that *no-one ever flew the Atlantic on a social construct* (Pavitt, 1998). However, this paper accepts that public attitudes to nuclear power are socially constructed and that these attitudes, provided that the resulting policy implementation is safe enough, should properly have a role in shaping policy for nuclear power.

In calling for greater levels of democratic leadership in nuclear power decision-making it is important to stress that we must not confuse public opinion with that of pressure groups and non-governmental organisations. Such bodies are important stakeholders to decision making, but this paper draws a firm distinction between such attitudes and those of the general public. It is the public voice that this paper seeks to amplify, not the lobbying of single-issue pressure groups.

This paper concentrates on the premise that public acceptance will be key to the future of nuclear power. Polling by MORI (figure 3) illustrates that recently the proportion of the British public with a positive opinion about nuclear power has started to exceed those with a negative opinion. Even more importantly, however, roughly half the British public have no real opinion (Knight, 2005). This paper does not argue that if the economic and environmental benefits of nuclear power are real then policy-makers should seek to persuade the public to accept the nuclear option. Rather it is suggested here that public attitudes must be a component of the policy process from the start. An open and transparent approach is to be preferred as a bulwark against authoritarianism. The MORI data tell us that as we enter a period of potential nuclear renaissance we must not just accommodate the views of those with strong opinions, but also recognise that many in the British population do not, at present, care very much.

"How favourable or unfavourable are your overall opinions or impressions of the nuclear industry/nuclear energy?"

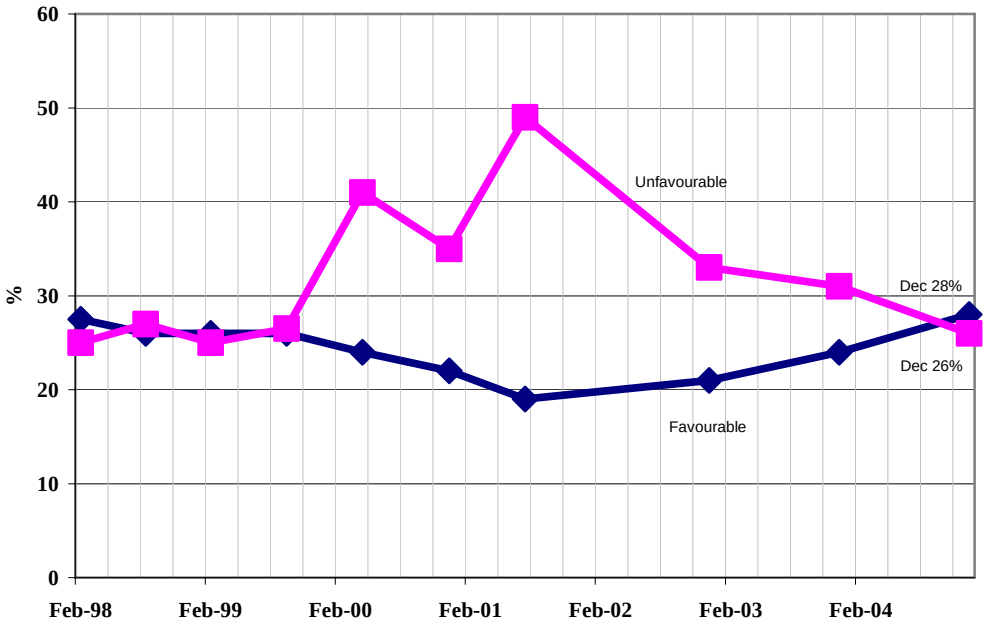

Figure 3 MORI All Great Britain general public polling of public attitudes to the nuclear industry (Base MORI Omnibus polling. Approximately2000 face-to-face interviews of the general public aged 15 and over at 210 sampling points) (Knight, 2005)

Conclusions

Nuclear power has many beneficial attributes that motivate its consideration as an important contribution to future global energy supply. In order to play such a role this paper suggests that it is important that policy and decision making for nuclear power is carried out in new and more inclusive ways. Nuclear power must move fully to a paradigm characterised by democracy and consensus. In this author's opinion a nuclear renaissance in Western Europe is only possible if founded upon principles of informed consent and stakeholder-based decision-making. The nuclear industry that results from more socially constructed processes may not be quite as safe and may be somewhat more expensive than that suggested by the technocratic experts, but within reason such concessions are both appropriate and proper. If such a democratic future for nuclear power will be safe enough, economically affordable and environmentally benign then this author recommends that policy-makers support its development. Indeed, if nuclear power is to endure, the coming nuclear renaissance must be accompanied by a *nuclear enlightenment*.

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