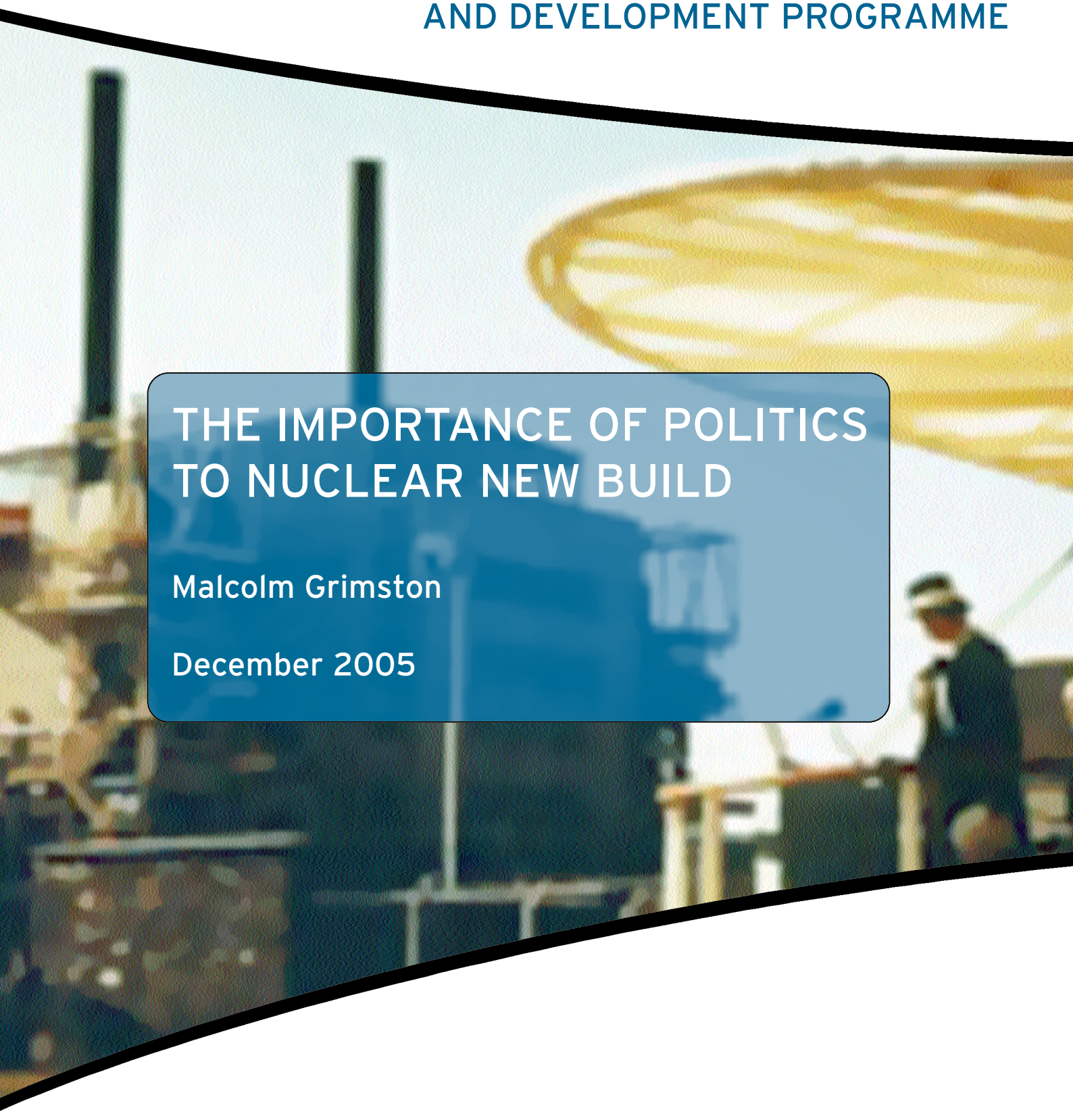
ENERGY, ENVIRONMENT
AND DEVELOPMENT PROGRAMME



THE IMPORTANCE OF POLITICS TO NUCLEAR NEW BUILD

Malcolm Grimston

December 2005

CHATHAM HOUSE

The Importance of Politics to Nuclear New Build

An examination of the relationship between political, scientific and public mindsets and its influence on decision-making in the scientific and technical field

Malcolm Grimston

REPORT

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December 2005 Malcolm Grimston

CONTENTS

FIGURES AND TABLES

SUMMARY

Though difficult to model as accurately as, say, the effects of oil price or the influence of climate change on decision-making in energy, the stance of the political establishment, locally, nationally and internationally, towards a major technical-scientific issue such as nuclear energy can be enormously important.

It is difficult to identify solid themes in the evolving relationship between the nuclear industry and the political establishments in various settings. For example, it is in the nature of politics that values are debated, often passionately, between members of the same community, to the extent that prevailing political fashions, for example the neoliberalism of the last decade of the twentieth century, however deeply they may seem to be ingrained, will always have dissenters. Even if we believe we can identify national political 'styles', they can differ considerably from country to country and from time to time. If the politics of Scandinavia can be described as 'consensual', that of the Anglo-Saxon countries as 'confrontational' and 'fragmented', those of some of the Romance countries as 'centralist' (in which the state is expected to play a major role) these labels are useful only insofar as their limitations are recognized. Prevailing political cultures during wartime or other times of national stress are often very different from those which may pertain in prolonged periods of peace and economic prosperity.

Nonetheless, certain tentative themes can be recognized in this changing relationship.

When nuclear energy emerged in the post-war years it was the recipient of large amounts of support, both political and financial, from a wide range of governments. This was partly as a result of recognition of its potential as a new source of energy; partly perhaps as a political cover for nuclear weapons programmes which might otherwise have attracted more opposition; partly owing to the great faith that politicians put in scientists and the very concept of 'progress'. (On the scientists' part, developing nuclear energy represented a way to salve their conscience by turning the devastating destructive force of nuclear technology towards a more benign purpose.)

Nuclear energy at this stage mapped well onto the prevailing political and social fashion in most developed countries – one of considerable 'deference' towards experts and decision-makers, driven in part by a recognition that after the War things would be difficult for a long time and that governments needed to take bold decisions, be they in the realm of welfare reform or industrial policy. In effect, politics (as the arena for decision-making), science (as a source not only of technical input but also of legitimacy for those decisions) and the public (prepared to defer to both and to surrender some of their individual 'rights' as long as overall progress was maintained) were able to work in considerable harmony. The prevailing societal ethic was a utilitarian one – there was a widespread assumption that policy was to be made on the basis of the greatest good for the greatest number, even if some individuals suffered disadvantage in the process.

As time passed, this consensus broke down, though to different extents in different countries. At first the fault lines appeared between politics/science on the one hand and the public, or growing numbers of members of the public, on the other. As post-war austerity was replaced by economic prosperity, so other profound social changes came to threaten the hegemony of the political/scientific establishment. People became more individualistic, traditional religion was replaced by cults, formal dress was replaced by informality (and even open nudity!) among younger generations, drug taking became

more common and young people were encouraged to 'tune in, turn on and drop out' by academic gurus like Timothy Leary and Allen Ginsberg.[1] It is of course bizarre to claim that all members of the population, or even more than a small minority, ever took up such activities but a general decline in the awe with which royalty, politicians, doctors, clergymen and 'experts' were held was clear. The rights of individuals became more important than was typical of societies under external pressure.

For a while the establishment could ride these changes – for example, large numbers of new nuclear reactors were ordered in the 1970s and 1980s, and indeed the economic decline of the 1970s, driven largely by the massive increase in the oil price in 1973, presaged a more subdued decade in which the strong political leadership (or out-of-touch, even uncaring, authoritarianism, depending on one's standpoint) of figures like Margaret Thatcher and Ronald Reagan could flourish in a way that might have been more difficult a decade earlier (or later). Science continued to play its role of not only supporting but to a large degree setting the direction of government policy, politicians by and large continuing to view the pronouncements of well-established scientific figures with close to blind faith. One can imagine that scientists were torn between a desire to make sure that politicians understood the inherent limitations of scientific inquiry (which cannot even in principle offer certain predications of the future, only well-based guesswork) while at the same time enjoying the social cachet of exerting such influence over the great and good.

Through the 1980s and 1990s (though it had been presaged by writers like C.P. Snow a quarter of a century earlier[2]) the commonality of interest and the close interaction between scientific and political cultures began to disintegrate. 'Big science', as represented perhaps most spectacularly by the space programme, fell out of favour and governments, with a few notable exceptions (Japan, France), drastically reduced expenditure on 'blue skies' research and development. In part this schism came about through deliberate (and often successful) attempts by the opponents of technology, increasing numbers of whom were being elected into parliaments, to undermine the scientific basis of decision-making, including the assumption that scientists could be regarded as founts of unbiased 'truths'. In this they were aided by the behaviour of some scientists working for major corporations who seemed to be prepared to allow their views to be used (or covered up) in such a way as to promote the financial interests of their sponsors. (Research into the health effects of smoking tobacco became the *cause célèbre*, both because of the delay in the scientific community's taking up the cause and because of the failure of some scientists to make their findings public.) In part it was also because of a growing number of examples of 'failure' in the science on which decisions had been based – the nuclear accidents at Three Mile Island in 1979 and Chernobyl in 1986 were particularly influential, as were such events as the Bhopal chemical disaster in 1984 and the explosion of the Challenger space shuttle in 1986.

It was surprisingly easy to create a schism between science and politics because it seems that the two never really understood each other. Indeed, the end of the twentieth century was a time of growing suspicion: scientists were becoming frustrated that

[1] In *The Downwave: Surviving the Second Depression* (Milestone Publications: Portsmouth, Hants, 1983, ISBN 0 903852 38 1), Robert Beckman argues that a whole range of social factors, such as formality of dress, levels of church-going, tastes in music etc. can be correlated to perceptions of economic prosperity and comfort.

[2] C.P. Snow, *The Two Cultures and the Scientific revolution*, Cambridge University Press, 1959, reprinted 1993.

politicians were requiring 'right' answers to simplistic questions of the kind the science cannot answer and accusing them of only being interested in the next election, while politicians were becoming increasingly annoyed at the difficulty of getting a straight answer which could subsequently be relied upon and the scientists' inability to recognize the constraints of decision-making in a democratic context. So, for example, scientists during the Bovine Spongiform Encephalopathy (BSE) affair of the 1980s/1990s were:

> both deliberately and inadvertently utilised to provide spurious scientific legitimation for policy decisions which government officials believed ministers, other government departments, the meat industry and the general public might not otherwise accept.[3]

The similarities between the paths followed by controversies in widely ranging scientific fields are striking. Typically they involve issues in which an activity is alleged to have an effect on a small number of people, in circumstances where no clear causal relationship can be determined. At first politicians and (some) scientists dismiss fears as unfounded, an action which often exacerbates the initial concerns by adding suspicions of 'cover-up'. The media identify and promote individuals who claim to have been affected by the activity in question and these individuals are often given at least the same degree of airtime and prominence as large-scale studies which imply a very small risk, if any. Politicians now set up a committee, drawn from 'experts' and non-experts, in the hope that it will provide a clean bill of health for the activity. This cannot happen – the scientists will always argue in effect that a negative cannot be proved, while the activists will stress that it has not 'yet' been proved that the activity is harmless and so it should be stopped. The outcome, in many cases, is regulatory action that puts barriers in the way of developing new technologies, however beneficial they may be.

Tensions among the scientific and political establishments and the public have emerged at times of economic prosperity in many developed countries. As far as many members of the public are concerned there is no apparent need for radical political action to protect the fabric of our way of life (as there might have been, say, at times of war or prolonged industrial unrest). Society is not any happier – our anxieties simply get transferred onto other potential threats such as mobile phone microwaves in the environment, which by any reasonable standards are patently much less severe – but there is less space for strong political decision-making in response to future threats where this may be seen to violate the rights of some individuals, however few.

Ironically, it seems that while thoroughgoing 'strong/authoritarian' or 'consensual/weak' modes of leadership can be successful in delivering implementable policy in the realm of scientific controversy, to fall between these extremes may be less so. The search for a site for a radioactive waste repository seems to have been concluded in Finland and Sweden (where local people have been kept at the centre of the decision-making process throughout) and in the USA (where a firm federal decision to use Yucca Mountain in Nevada was pursued in the face of widespread local opposition). By contrast, those countries which have made some attempt to accommodate public concerns, e.g. by including non-experts on advisory bodies, but which have continued to operate in conditions of considerable secrecy (it was only in 2005 that the list of sites

[3] http://www.ingentaconnect.com/content/beech/spp/2001/00000028/00000002/art00002, E. Millstone and P. van Zwanenberg , ' Politics of expert advice: lessons from the early history of the BSE saga', *Science and Public Policy* **28** (2) (1 April 2001).

considered for waste repositories in the UK in the 1980s was released to the public, and then only after an application under the new Freedom of Information Act[4]) have made relatively little progress. Undoubtedly national political characteristics and history play a part in these different approaches to decision-making – there can be no assumption that what has 'worked' for one country or region would be appropriate for another.

As a response to the growing public scepticism about the role of science in decision-making (and perhaps to the need to be seen to be 'doing something' without having to do something), politicians have attempted to rebuild a relationship of trust with the public by downgrading technical expertise or even writing it out of the loop. The panels charged with finding 'solutions' to matter such as radioactive waste management, the health effects of mobile phone masts, BSE, foot-and-mouth etc. are increasingly populated by individuals with no technical knowledge of the topic in question and indeed often an antipathy towards such expertise.

Yet, properly used, science has a vital role to play in decision-making. The scientific method, while not offering sure and certain knowledge, especially when dealing with relatively uncommon potential health threats, is likely to provide advice which is closer to the truth, and therefore more useful, than that emerging from religion, gossip or ideology.[5] As long as a suitable attitude is taken to uncertainty this must lead to better decision-making. Even Hume, who takes the extreme sceptical position that simply because something has always happened in the past is no proof that it will happen in the future, argues that only a fool would live life on that basis.[6]

Such reflections are particularly vital when decisions taken or ducked today will have implications long, long after the end of the term of office of the politicians taking them. It is wrong to say that politicians are never motivated by long-term factors – all leaders want to ensure their place in history – but how these desires can be integrated with the short-term strains of the electoral timetable is not always clear. Nuclear energy is particularly (but not uniquely) vulnerable to any impression that politicians in the future may change the rules in a more or less capricious and unpredictable way. The initial investment costs of nuclear energy represent a higher proportion of total costs than is the case with most other ways of making electricity (notably Combined Cycle Gas Turbine, CCGT). To ensure a fair rate of return on the project it therefore requires a stable business environment for a rather longer period of time. If, say, it is perceived that a change in political control might bring with it more stringent regulations (or even a formal phase-out policy), then the economic risk associated with investment in nuclear plant becomes high and possibly unmanageable. In the most extreme case, the Shoreham nuclear station at Long Island, New York was closed in 1989 before commercial operation began because it was refused an operating licence on the grounds

[4] http://www.timesonline.co.uk/article/0,,2-1649479,00.html, M. Henderson, 'Secret list of nuclear dump sites revealed', *The Times Online* (11 June 2005).

[5] This is not to denigrate the importance of non-scientific sources of 'knowledge' when it comes to settling our personal values and sense of right and wrong. In the view of this author, though, these sources are less reliable than the output of properly conducted science when it comes to interpreting the behaviour of the physical universe.

[6] 'Should it be asked me whether ... I be really one of those sceptics who hold that everything is uncertain, I should reply that neither I nor any other person was ever sincerely and constantly of that opinion. I dine, I play backgammon, I converse and am merry with my friends and when after three or four hours of amusement I would return to these speculations, they appear so cold and strange and ridiculous that I cannot find in my heart to enter into them any further. Thus the sceptic still continues to reason and believe though he asserts he cannot defend his reason by reason.' D. Hume, *A Treatise of Human Nature* (1739).

that it could not comply with evacuation requirements introduced after construction had started. The Long Island Lighting Company was effectively bankrupted by the affair.

The challenge for politicians and the 'consumers' of their decisions, then, is twofold. First, how to reintegrate science into decision-making without making the mistakes of the past in which some scientists were given almost a free hand over policy development.[7] Secondly, how to take strong and possibly unpopular decisions before the impending crises of, say, energy shortages and climate change become unmanageable (quite possibly after the politician in question has left office, thereby risking taking the short-term pain while receiving little of the long-term gain). Unless these challenges are overcome, complex technologies like nuclear energy, even if they have a useful potential role to play, are likely to be excluded on grounds which, from an external viewpoint, will be regarded as irrational. (This is not, of course, to argue that there are no rational grounds for opposing any particular technology.)

There are certainly political risks associated with firm action over controversial issues, especially when society is not yet ready to acknowledge the need for such action. But so too are there political risks in ducking difficult questions – the risk of being seen to be weak during or after one's term of office. Politics is not merely a matter of getting through the next election; some decisions are inevitably longer-term, and the success or otherwise of politicians in dealing with them will cast long shadows.

[7] One issue within this broad topic might be how to create institutions and incentives to build interdisciplinary scientific expertise, with a view to establishing reliable bases of 'facts', explaining different standpoints and outlining the advantages and disadvantages of various courses of action, hence aiding individuals who wish to become involved in the debate.

1. INTRODUCTION: WHAT DO WE WANT FROM OUR ENERGY SUPPLY SYSTEMS?

It is often claimed that we have three main requirements of our energy supplies.

First, they must be *secure and reliable*. For example, in much of Western Europe in the year 2000 there were protests about the price of petrol. Within a week the consequent disruption to supplies practically brought the countries involved to a standstill. About two-thirds of 'proven' world oil reserves (known reserves which can be extracted profitably at today's oil prices) are owned by just five countries in the Middle East, and over 70 per cent of world gas reserves are in the Middle East and the Former Soviet Union. Many countries are nervous about becoming too dependent on imports from those areas. Secure supplies are especially important in the case of electricity. Power cuts (or even significant degradation of the quality of the electricity supply) of very short duration indeed can be enough to disrupt complex computerized networks. Longer power cuts can result in economic damage through the loss of a freezer full of food, a day's production in the workplace or vital public transport links, as well as potentially enormous health and social consequences.

Secondly, they must be *environmentally acceptable*. By far the most worrying environmental threat is that of climate change but there are many others – acid rain, the health effects of smoke, the risk of radioactive contamination, major local environmental disruption, visual intrusion and threats to wildlife caused by a tidal barrage or a wind farm and so on. All sources of energy have adverse environmental effects and it can be a very difficult job to compare and evaluate them.

Thirdly, they must be as *economic* as possible. Energy is an important cost to businesses and industry, and the more society spends on providing energy the less it has to spend on other things. Of course, governments may decide to tax energy use instead of taxing, say, employment (i.e. increase the *price* of energy for policy reasons, perhaps to encourage energy efficiency) but it does nobody any good if the underlying costs of power production are higher than they need be.

However, a cursory glance at history shows that there is a fourth requirement. Energy supplies must also be *socially and politically acceptable*. It is this category which will form the focus of this paper. It is more difficult to define than the other three – it involves such disparate matters as sensitivity to communities associated with a particular energy source, public acceptability, help for people who cannot afford their energy bills and, of course, calculations of the electoral consequences of various policies – and as a result it seems to have received rather less attention in the literature. However, its importance should not be underestimated. Political action (often expressed through the regulatory system) – or even the mere perception that such action may happen – can be extremely beneficial or extremely damaging for the prospects of investment in an industry such as nuclear power and can even act as an absolute barrier. A lukewarm or worse political attitude towards the construction or operation of nuclear facilities, say, could increase the costs of nuclear-generated electricity in a number of ways. There may be delays during construction or in achieving an initial operating licence, or interruptions in operation. Extra physical or operational security measures might be demanded, perhaps in response to a potential terrorist situation even if there is no direct evidence of a threat. Implementing such measures may be especially costly if they involve 'backfitting' an

existing design. The costs of site selection, evaluation and the licensing process itself can increase. The costs of transporting nuclear materials can escalate, because of increased requirements for security against protest or the need to find new routes. The economic risk associated with uncertainty results in demands for higher rates of return on investment, an especially serious issue for highly capital-intensive technologies such as nuclear power.

The problem for policymakers is that these four requirements are often in conflict with each other. There are many examples of energy policy being skewed to support a particularly powerful political lobby (notably the coal industry in several countries at various times) at the expense of supply security, low prices or the environment. To make matters more complicated still, the other requirements of our energy systems also have profound political implications. However much a government might argue publicly that energy is a matter for the marketplace, severe power outages or price rises will ultimately land on the doorstep of the governing regime. (Whether the risk of climate change will have such marked implications at the ballot box is not clear.) The 1990s, with the emergence of the new Combined Cycle Gas Turbine technology (both cheaper and more environmentally acceptable than the predominant coal-fired stations of the day), sustained low oil (and therefore gas) prices and the discovery of significant new gas reserves, were a period of rare comfort in the energy field – by the middle years of the following decade things are once again looking challenging, as they had in the 1970s.

The energy industries themselves have made it easier for governments to duck issues (e.g. to reduce global spending on energy R&D) by fighting among themselves rather than by encouraging a holistic approach to impending challenges in the energy and environmental fields. Internal bickering – 'renewables are too expensive', 'fossil fuels are too dirty', 'nuclear power is too risky', 'fusion will never work' etc. – makes it more difficult for governments to show political leadership with respect to the energy sector (or, depending on one's viewpoint, makes it easier for governments to abdicate responsibility).[8]

The direct effects of political antipathy

In extremis political opposition can lead to a fully completed plant being refused an operating licence or to a government taking steps to prevent nuclear construction or close down existing facilities before the end of their technical lifetimes. Since 1978, for example, some 25 nuclear power plants with combined capacity of some 16 GW, and one MOx fuel production plant, have been closed or halted in advanced stages of construction for non-economic reasons in six OECD countries (Austria, Germany, Italy, Spain, Sweden and the USA), some as a direct result of referenda. Most of these closures were carried out in the years after the Chernobyl accident in 1986, although the 720 MW Tullnerfeld reactor in Austria was refused an operating licence on completion after a referendum in 1978. Italy no longer operates nuclear power reactors, having closed three operating plants after a 1987 referendum. Germany and Sweden have adopted formal phase-out policies by law (the Netherlands abandoned such a policy in 2002), Switzerland adopted a ten-year moratorium on new construction in 1990 (though

[8] The issue is discussed in President's Council of Advisors on Science and Technology, *Report to the President on federal energy research and development for the challenges of the twenty-first century*, Washington, DC, 1977.

proposals to phase out nuclear energy and to reintroduce the moratorium were rejected in two referenda in 2003[9]) and Belgium has taken a policy decision to phase out nuclear power. A number of countries which do not have operating nuclear power plants, such as Australia, Austria, Denmark, Greece, Ireland, Norway and Poland, have put in place legal or policy obstacles to developing nuclear power.[10]

Thus, whether or not the public really is deeply suspicious of nuclear technology in these countries and whether or not public fears are justified, political stances have had, and will presumably continue to have, profound implications for nuclear power's development or failure to develop.

Shoreham – a case study

The most dramatic example of how political attitudes can change and of the effect of political and regulatory action on nuclear investment involved the Shoreham nuclear power station, Long Island, New York State.

In 1965, when LILCO (Long Island Light Company) first announced its intention to build a nuclear plant somewhere in Suffolk County, elected officials enthusiastically embraced the project. By the time Shoreham was fully decommissioned in October 1994, its total costs of $6 billion had severely weakened the regional economy by saddling Long Island with some of the highest electricity prices in the USA.

Throughout the thirty-year saga it is possible to find examples of where the protagonists of the project appear to have misunderstood the changing political and social environment, with ultimately disastrous consequences.

Within a year of its first announcement, LILCO had bought a 455-acre site between the sparsely populated hamlets of Shoreham and Wading River and was declaring its new plant would be on line by 1973, at a cost of $65-$75 million. Presumably driven on by enthusiasm born of the apparent ease of the early stages of the project, LILCO also bought land for a second nuclear plant, in affluent Lloyd Harbor. This time local residents reacted negatively and a well-funded campaign of opposition was launched.

In 1968 LILCO decided to increase the size of Shoreham from 540 to 820 MW. This decision (and plans to build two more reactors in Jamesport which were abandoned at an early stage) delayed the timetable and added significantly to the costs of Shoreham. More important, the delays provided crucial time for anti-nuclear activism to spread beyond Lloyd Harbor (by 1969 the proposal for the reactor there had been killed off) and take root across Long Island.

The company's attitude and apparent incompetence were unhelpful. According to Ira Freilicher, LILCO's chief spokesman at the time, 'Early in the game, the opposition was treated sort of disdainfully. We handled them in a more confrontational and patronizing way than we should have. It was an arrogance on our part'. By the late 1970s the cost

[9] http://www.enviros.com/vrepository/not_subscribed/country/switzerland/index.cfm, Enviros, The Virtual Repository of Nuclear Information, 2005.
[10] http://www.iea.org/textbase/nppdf/free/2000/nuclear2001.pdf, IEA, *Nuclear Power in the OECD*, OECD/IEA, Paris, 2001.

of the plant was approaching $2 billion, mostly because of low worker productivity as well as design changes ordered by federal regulators.

The 1979 Three Mile Island accident in Pennsylvania served to promote anti-nuclear sentiment and activism and Shoreham became a focal point. In June 1979, 15,000 protesters met at Shoreham for the largest demonstration in Long Island history. Furthermore, Three Mile Island led to federal regulators declaring that operators of nuclear plants would have to work out evacuation plans in cooperation with state and local governments. As opposition spread and electricity prices increased, the united pro-Shoreham front among Long Island's political and business leaders began to collapse. In February 1983 the Suffolk Legislature declared (in a 15-1 vote) that the county could not be safely evacuated. New York's newly elected governor, Mario Cuomo, ordered state officials not to approve any LILCO-sponsored evacuation plan.

Despite these setbacks LILCO pressed ahead and completed Shoreham in 1984, winning federal permission for low power tests the following year. But by the late 1980s the failure to agree evacuation plans was still delaying an operating licence for the plant. Dissatisfaction with LILCO as a company was also growing, caused in part by anger over the utility's poor performance in restoring power after Hurricane Gloria struck in 1985.

By now whatever political support for the plant remained had evaporated. The Chernobyl accident in Ukraine in 1986 made commissioning even less attractive, though the event seemed to have had little immediate effect on American views of nuclear power. (For some years network news polls had shown about 60 per cent of the public opposed to building any new plants. Similar surveys taken after the Soviet disaster did not reveal any marked increase in the number of opponents.[11])

A protestor at the Shoreham nuclear power station

[11] http://www.time.com/time/daily/chernobyl/860512.usnuclear.html, P. Stoler , 'Bracing for the fallout – the American power industry prepares to face heavy weather', *Time,* 12 May 1986.

The New York legislature created the Long Island Power Authority (LIPA) as a vehicle to close Shoreham and take over the company. In February 1989, after more than two years of negotiations and abortive deals, Cuomo and the chairman of LILCO signed an agreement that prevented the plant ever operating but made electricity consumers responsible for most of Shoreham's costs.

The repercussions of the Shoreham affair continued for many years and in many theatres. In 1995 LILCO's very high electricity prices caused Governor Cuomo's successor, George Pataki, to broker a partial public takeover of LILCO by LIPA.

Shoreham demonstrates clearly the dangers that face investors in nuclear energy. As a source of electricity which is heavily capital-intensive, the economics of nuclear energy are particularly sensitive to changes in political stances or regulation which will have significant effects on the duration and costs of the construction phase or which may delay (or even prevent) opening of the plant once it is completed.

The Shoreham incident was a negative experience for many other players. Politicians and business people who had supported both the scheme and LILCO suffered considerable embarrassment (as well as financial loss). The affair emphasizes the impression that nuclear energy is not merely a recipient of political fashion – in some key cases it has actually been an important element in forming those fashions. It has been argued that the public campaign over Shoreham launched an anti-authoritarian brand of citizen activism that was to transform local politics, not just in Long Island, as people realized they could overcome the combined will of a major industry and the Federal government.

> The Shoreham reactor never produced a kilowatt of commercial power, but it proved to be an accomplished breeder of cynicism and distrust. Shoreham forever changed the way Long Islanders view authority. Born in an era of boundless optimism, even naïveté, about the future, Shoreham died a slow and tortuous death at a time when Long Islanders were finally facing the consequences of supercharged growth and weren't liking much of what they saw.[12]

2. POLITICS AND NUCLEAR ENERGY – THE EARLY YEARS

Of course, the influence of major events such as the accidents at Three Mile Island in 1979 and Chernobyl in 1986, and of ongoing debates such as the apparent increase in juvenile leukaemia rates near some of the older nuclear establishments (notably Sellafield in the UK), on public and political attitudes towards nuclear energy should not be underestimated. Even relatively minor events at nuclear installations tend to attract widespread media coverage, while economic problems such as have beset nuclear construction programmes in the USA and which almost bankrupted British Energy in 2002 also have their effect, as do the activities of a committed anti-nuclear movement in many countries. (At the same time, growing concerns about climate change and limited

[12] http://www.newsday.com/community/guide/lihistory/ny-history-hs9shore,0,563942.story?coll=ny-lihistory-navigation, D. Fagin, *Lights out at Shoreham– anti-nuclear activism spurs the closing of a new $6 billion plant*, newsday.com, 1995.

reserves of fossil fuels might be expected to increase the attractiveness of nuclear energy.)

However, these events also happen against a background of changing societal views and ethics. For example, clear growth in activism against nuclear energy was seen throughout the 1970s – famously, *The China Syndrome*, a motion picture about a potential accident at a nuclear power station, was released just three weeks before the Three Mile Island accident and included the line that in the event of a major accident 'an area the size of Pennsylvania would be left uninhabitable'.

In the two decades following the end of the Second World War nuclear energy occupied a highly privileged position in many countries.[13] The sheer degree to which government-backed nuclear technology flourished in the post-war period is easy to forget. In addition to the 31 countries which went on to develop commercial civil nuclear energy, the International Atomic Energy Agency (IAEA) lists a further 38 have which have operated research reactors, mostly commissioned in the 1950s, 1960s and 1970s. These include nations as diverse as Algeria (first operation in 1989), Australia (1958), Bangladesh (1986), Colombia (1965), Congo (1959), Egypt (1961), Ghana (1994), Jamaica (1984), Norway (1959), Peru (1978), Poland (1958), Thailand (1977), Turkey (1962), Venezuela (1960) and Vietnam (1963).[14] In at least some cases, for example the development of the Windscale piles in the United Kingdom (the first of which caught fire in 1957), it can be argued that government pressure pushed scientists and engineers into taking dangerous risks in the desire to fulfil urgent political demands.[15]

Owing to the highly technical nature of the subject, even many politicians felt unable to engage meaningfully in the details of the debate. Responsibility not only for implementing nuclear policy, but also for setting that policy, was to a considerable extent vested in bodies comprising or representing nuclear 'experts'. It was perhaps inevitable then that a technocratic mode of decision-making became dominant, to the detriment of dialogue with and control by the normal democratic structures. The secrecy associated with military uses of nuclear materials exacerbated this.

Opposition to the military applications of nuclear technology began to be observed almost immediately after the explosions at Hiroshima and Nagasaki in 1945. The Atomic Scientists of Chicago (the site of the first controlled fission experiment in 1942) was formed in 1945 to sound warnings against believing all of the official pro-nuclear pronouncements. The *Bulletin of Atomic Scientists* was first published in December 1945, and in an early edition Albert Einstein wrote:

> The unleashed power of the atom has changed everything save our modes of thinking, and thus we drift toward unparalleled catastrophe.

[13] For example, the preamble to the EURATOM Treaty (http://europa.eu.int/abc/obj/treaties/en/entr39a.htm) of 1957 states: 'Nuclear energy represents an essential resource for the development and invigoration of industry and will permit the advancement of the cause of peace'.

[14] http://www.iaea.org/worldatom/rrdb/, IAEA, *Nuclear research reactors in the world*, IAEA,Vienna, 1999.

[15] More recently, a significant contribution to the Chernobyl accident in 1986 seems to have been overt and assumed demands on the operators from local politicians to provide extra output from the plant and to ensure that the 'safety' experiment being carried out could be repeated if necessary, which resulted in their operating the plant well outside its design parameters. See M. Grimston, 'Chernobyl and Bhopal ten years on – comparisons and contrasts' in J. Lewins and M. Becker (eds), *Advances in Nuclear Science and Technology 24*, Plenum, New York, 1997.

The forerunner of the Campaign for Nuclear Disarmament (CND), the UK pressure group opposing nuclear weapons, was formed in 1957.

However, it was in the 1970s that organized opposition to civil nuclear energy began to develop seriously. Greenpeace and Friends of the Earth were formed in 1971 and although nuclear energy was not one of their earliest concerns it grew in importance through the decade. The Sierra Club reversed its pro-nuclear energy stance in 1974.[16] As noted above, the accidents at Three Mile Island (1979) and Chernobyl (1986) gave further impetus to these campaigns.

At this stage the political and scientific cultures were still broadly working together, it being presumed that members of the public (or pressure groups) who opposed a particular bit of scientific/technical 'progress' were either out of touch with the norms of society or would soon come round. Those in society who did question the prevailing 'work ethic' and deference to established authority generally opposed politicians and the scientific/technical community with equal vigour, bolstered by a growing number of examples of where 'supine' politicians had allegedly let commercial interests and their employed scientists run amok, with significant detriment to the environment and human health. The 'all pull together' ethic of the wartime years and their aftermath was being replaced by a more individualistic society in which personal (and even environmental) rights took a more prominent position.

3. THE 1960S AND BEYOND – CHANGING SOCIETAL ETHICS

The scientific mindset, like that of politicians in times of national crisis, is one which tends to take or recommend decisions on a fundamentally utilitarian basis, seeking 'the greatest good for the greatest number'. The scientific reliance on statistical methods of enquiry fits well with utilitarianism – indeed, Jeremy Bentham, the founder of modern utilitarianism, proposed a 'felicific calculus' to determine mathematically the morality of various courses of action.[17] When the basic ethic of society at large is broadly utilitarian (as suggested earlier, this seems to be the case during times when society is under some kind of stress or threat) the politician often seems happy to delegate decision-making to the technical community – a famous example was the stance of the Eisenhower regime in the early days of nuclear technology, which, as noted earlier, took the view that nuclear science was by its nature too difficult for lay people, including politicians, to understand so the responsibility for formulating policy (as well as carrying it out) should lie with the Nuclear Regulatory Commission, NRC. Since society also tends to be more deferential towards 'the experts' when under external pressure, this proved a practicable way of taking and implementing large-scale decisions with national implications. One can of course question whether decisions taken in such isolation from the needs of the society would always deliver good 'value for money' in terms of the outcome for 'ordinary' people. The vast sums spent on nuclear research in the UK in the 1960s, resulting in the creation of a large number of apparently dead-end designs – at the end of which, in the view of many commentators, government 'chose the wrong one'

[16] http://www.sierraclub.org/policy/conservation/nuc-power.asp, Sierra Club (December 1974), *Sierra Club Policies – Nuclear Power.*

[17] http://www.constitution.org/jb/pml_04.txt, J. Bentham (1781), *Introduction to the Principles of Morals and Legislation.* Batoche Books, Kitchener, Canada.

– do not now appear to have represented the best possible public policy. But at least decisions with implications for the nation as a whole could be taken and implemented.

More acute problems have arisen, though, as a result of the recent shift towards a more rights-based approach to ethics (variously referred to as a Kantian, contractarian or deontological approach, though its roots stretch back to the concept of the 'social contract' to be found in the work of philosophers such as Hobbes, Locke and Rousseau).[18] Differences between these two philosophies which are particularly relevant to nuclear energy are considered in Appendix 3.

The growth of a rights-based ethic has seen the growing influence of anecdote and case study, often involving identified individual 'victims', when formulating policy, at the expense of statistical analysis. The media will often put an interview with an alleged victim of a supposed risk on an equal footing with a large-scale scientific study which has failed to confirm any link. Statements such as 'They're dealing with statistics – I'm dealing with people whose history I know'[19] are increasingly common.

In recent years the rights-based approach, to a greater or lesser extent in different countries, has gained considerable ground over the utilitarian in decision-making in a range of issues involving the interface between science and society. As far as the nuclear industry goes this has had several implications, e.g. the effective elimination of options such as the creation of international radioactive waste disposal sites in one or more of the less developed countries (which some might argue makes sense on utilitarian grounds but which is broadly recognized as being unfair in important respects), and 'dilute and disperse' approaches to waste management such as sea disposal, seen as carrying risks that material may contaminate third parties (and indeed non-human life) who may have no stake in the processes which created the waste. Other options and considerations, such as potential effects on neighbouring countries and the desirability of ongoing monitoring of wastes in a retrievable condition, have become more important in discussions.

While a utilitarian approach does, at least in theory, offer the possibility of coming to the single 'best' answer (if one has access to sufficiently good information and projections to chart the outcomes of each option with respect to human health and happiness), the rights-based approach is more prone to throw up clashes between equally valid 'rights'. For example, local communities surely have some right over activities affecting their locality (and indeed in some countries have an absolute veto in law), but the country at large may also have rights (and indeed obligations) to deal with national issues in a way that is sustainable. In the field of radioactive waste management it is the view of many federal governments that the interests of the country will be best served by developing a single deep geological repository, which may well ultimately involve forcing such a development on an unwilling host. As discussed in more detail later, in Finland this has not as yet proved problematic – indeed, the absolute right of veto may well have been an important factor in developing the trust between regulators, the federal government and the potential repository host municipality of Eurajoki necessary to move the debate forwards. However, it is obviously possible that all local communities might wish to

[18] One prominent proponent of the supremacy of individual rights was John Rawls, notably in *A Theory of Justice*, Harvard University Press, 1971.

[19] Janine Allis-Smith, quoted in http://www.guardian.co.uk/weekend/story/0,3605,1586031,00.html#article_continue, 'Blast from the past', *The Guardian* (8 October 2005).

exercise their (ethical or legal) right of veto, thus creating a conflict with the 'right' of the country as a whole to what in the eyes of the federal government is the best waste management approach. This is an area of particular tension in Switzerland, where the government has taken steps to remove the long-standing cantonal veto on waste management facilities.

The decline of deference – ethics, expertise and politics

The demands that society places on its leaders vary considerably depending on whether the dominant ethic is utilitarian or rights-based. In the former case – typical, as suggested earlier, of societies under some kind of threat (war, economic decline, industrial strife, severe environmental degradation etc.) – people tend to demand 'strong leadership'. This is seen most clearly during times of war. The rights of individuals tend to be subsumed in the needs of society at large – 'don't you know there's a war on?' – and big political gestures are often regarded as essential to maintain national morale.

This is not to say that the protection of individual rights through the judicial system is dismantled entirely. In a case brought in the UK in 1941 by a German national known as Robert Liversidge, who was detained as an enemy alien, against two Home Secretaries, Sir John Anderson and Herbert Morrison, Lord (James) Atkin of Aberdovey said:

> In this country amid the clash of arms, the laws are not silent. They may be changed but they speak the same language in war as in peace. It has always been one of the pillars of freedom, one of the principles of liberty for which on recent authority we are now fighting, that the judges are no respecters of persons and stand between the subject and any attempted encroachments on his liberty by the executive, alert to see that any coercive action is justified in law.

Nonetheless this was a dissenting opinion, the other four Law Lords finding for Anderson, and most people seemed comfortable and even keen to see individual rights subsumed into the greater good.[20]

By contrast, when society is feeling more comfortable and individual rights predominate, people seem to require leaders who are more consensual and do not take bold action. For example, there was widespread concern about the detention of Muslim suspects by the USA at Guantanamo Bay after the Iraq invasion, Atkin's words often being quoted.

One can argue that UK Prime Minister Margaret Thatcher was not notably different in her beliefs and style in 1990 than she had been in 1982 (at the time of the Falklands War) or in 1984 (during the miners' strike). However, while her style was enormously successful, in electoral terms, during the years in which the UK faced serious strains following the industrial unrest of the 'winter of discontent' in 1978/79, it seemed to have become a liability by the late 1980s, a time of economic prosperity and the end of the Cold War. (She was dismissed by her own MPs in 1990.) By contrast, Tony Blair's more consensual electoral style worked well in 1997 and 2001, but his support for President Bush over the Iraq invasion, in which it can be argued he showed similar resolve to that

[20] See http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2002/07/04/nlaw04.xml&sSheet=/news/2002/07/04/ixhome.html, J. Rozenberg, 'When law collides with foreign affairs', *Daily Telegraph* (2 July 2002).

displayed by Mrs Thatcher in 1982, alienated considerable numbers of British voters.[21] Whether a particular individual is a 'strong leader' or 'out of touch with ordinary people' (or at the other extreme is 'popular and consensual' or 'weak') may be as much a matter of the social and ethical environment in which they are operating as of their own particular actions.

A further feature of a society operating under a rights-based ethic seems to be reduced participation in traditional politics, and elections in particular, coupled with a growth in 'minor' or single-issue political parties. One can speculate that in part this is because people focus more on individual topics rather than looking for a government that can take a balanced view of all issues in an attempt to find the best mixture of policies from the point of view of the greatest number of citizens. (In the 2004 European Parliament elections in the UK, for example, on a turnout below 40 per cent, the two main parties, Conservative and Labour, for the first time since the 1920s, between them collected fewer than 50 per cent of votes cast, while the secessionist UK Independence Party pushed the traditional recipients of protest votes, the Liberal Democrats, into fourth place.[22]) Furthermore, political parties generally respond to a 'comfortable' electorate by moving towards what is perceived as the 'political centre' of the day: reduced turnout may also reflect a widespread feeling that there is 'little difference' between the major parties (in contrast, for example, to the chasm between the policies of the UK Conservative and Labour Parties throughout the 1980s).

It is an interesting question whether a society facing stress from a particular direction, say terrorism, may demand 'strong' action with respect to that threat (homeland security) while remaining as resistant as previously to such action in other fields (MMR vaccination or mobile phone masts). This is a particularly difficult point to assess given that we are discussing changes that are quite subtle. Very few individuals hold a consistent utilitarian or contractarian ethic on all possible political issues, and even in the most stressed 'utilitarian' society there will be some who continue to campaign for individual rights. History suggests that a particular government can be regarded as broadly utilitarian or contractarian over a wide range of issues and that people will accept this – since the Second World War in the UK only once (the Heath government of 1970 to 1974) has a government led by either Party failed to be re-elected at least once before losing office. However, this may not mean that 'the people' broadly hold to the same ethic with respect to issues which appear pressing and issues which appear unproblematic.

Be that as it may, observations such as those made above have important implications regarding a government's scope for action in emergency situations. At times of comfort government may organize itself in such a way as to appear to be as consensual or non-interventionist as possible, e.g. by legislating to protect the rights of local communities to reject projects of national importance or by divesting itself of the mechanisms whereby it might intervene in a particular industry or business. This may leave the government in a weak position if the need should arise to take decisive action in response to an emergency.

[21] It can also be argued that the nature of the risk to the UK was less clear in 2003 than in 1982. However, considerable effort had been expended on persuading the British people that Iraq possessed weapons of mass destruction, with some apparent success.

[22] http://www.parliament.uk/commons/lib/research/rp2004/rp04-050.pdf, House of Commons Library (2004), European Parliament elections 2004, Research Paper 04-50.

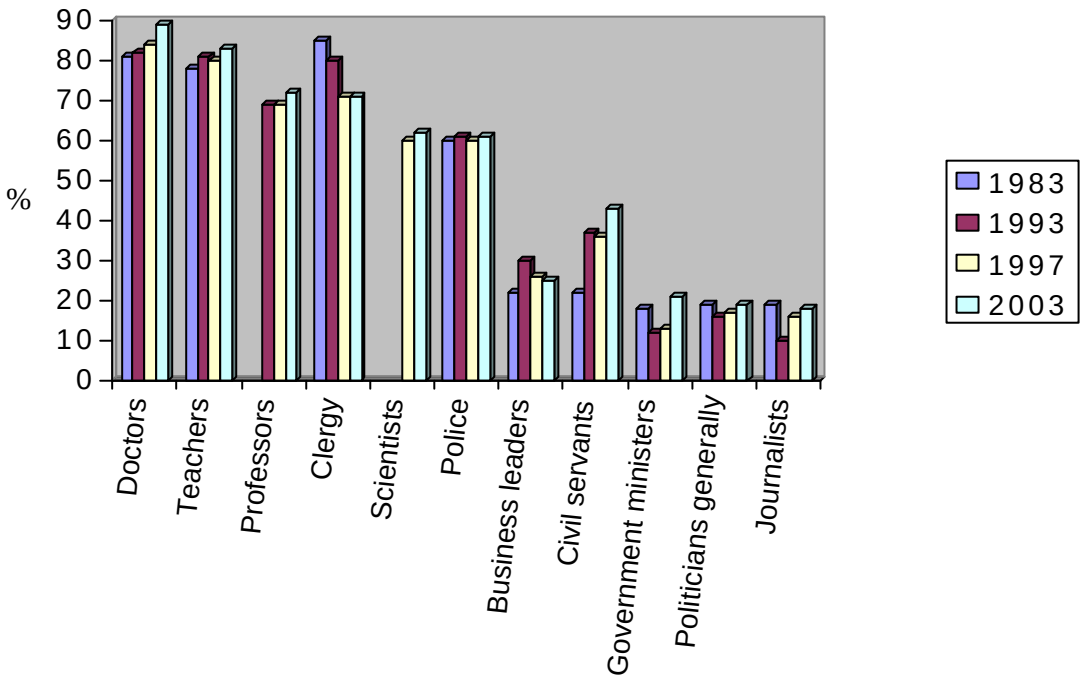
The timescales associated with nuclear energy create particularly difficult challenges. If politicians are acting in consensual mode and are unwilling to take controversial decisions, then it is unlikely that the guarantees of long-term stability required by heavily capital-intensive industries will be forthcoming.

Irreversible changes in societal ethics?

There seems to be an underlying assumption in much discussion about new methods of encouraging lay 'participation' in decision-making that the move towards a rights-based ethic represents an irreversible change in society. Certainly one factor which has contributed to increased participation at a local or single-issue level, the growth of communication through the Internet and modern telecommunications networks, represents a permanent transformation.

It is possible to exaggerate the extent of the 'decline in deference' in recent years. If the degree of trust in various institutions is taken as a measure then there has been little variation in the last twenty years, though the very low levels of trust expressed in politicians (and the media) are striking (see Figure 1).

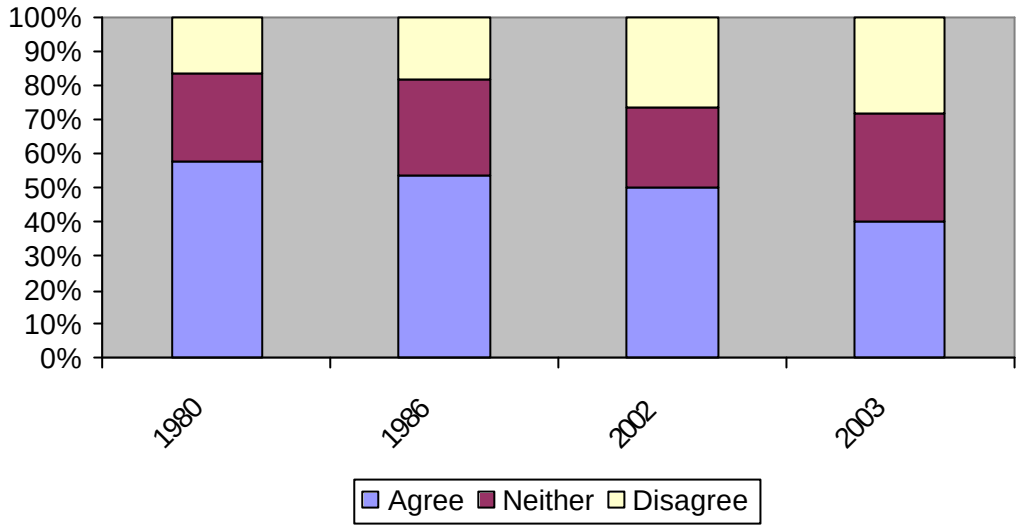
Figure 1: Proportion of the population which trusts selected types of professions in the UK[23]



However, as Figure 2 shows, there is evidence that trust in businesses has declined.

[23] http://www.bsi-global.com/British_Standards/CPU/futurefoundationconsumertrends.pdf, Future Foundation Projects, *The Impact of Consumer Trends on Standards,* 2004.

Figure 2: Proportion who agree/disagree with the statement 'Most companies in the UK are fair to consumers.'



It is also a mistake to believe that politicians have been universally respected until very recently. Quotes like 'under every stone lurks a politician'[24] can be found throughout history. Nonetheless, as noted earlier, a number of changes have occurred in recent years, including:

- a fall in numbers voting in elections;
- a growing tendency to join single-issue pressure groups rather than political parties;
- the rise of political satire (again hardly new but more prevalent since the early 1960s);
- an increase in people asserting their individuality;[25]
- growing informality in dress, social etiquette etc.,
- a growth in the extent to which people trust friends, family and other individuals as a source of information over 'official channels'.

Other changes in society, such as the growth of the mass media and modern communications techniques, and the replacement of extended families with their ingrained hierarchy of respect for older members by much smaller family units, often without as much deference towards parents, may also be relevant.

Some of these changes may be irreversible. This is not necessarily to say, however, that society at large has forever abandoned the utilitarian ethic in favour of individual rights. It is perfectly feasible that new threats to the stability of society – for example prolonged power outages, terrorist attacks or severe environmental damage – may lead to a reversal of the trend and a return to calls for 'strong leadership'. It was noticeable, for example, that the 2004 Presidential election in the USA drew the largest voter turnout

[24] http://classics.mit.edu/Aristophanes/thesmoph.pl.txt , Aristophanes (441 BC), *The Thesmophoriazusae*.
[25] The percentage of people agreeing that it is more important to 'fit in' than to be different from other people has fallen steadily from 49 in 1980 to 27 in 2002 – Future Foundations Project, op. cit.

since 1968 and the return of a candidate (George W. Bush) who was perceived by many Americans to have taken a strong stand against global terrorism after 9/11. In the UK, by contrast, which had at that time been practically unaffected by Middle Eastern terrorism, the support given by Prime Minister Blair to the US invasion of Iraq gave rise to unprecedented public protest and was subsequently believed to have been a significant factor in the fall in his party's vote in the 2005 general election (on a turnout that was near historical lows despite the widespread introduction of postal voting). It is too early to tell whether the terrorist attacks in London on 7 July 2005 will have an effect on prevailing societal ethics.

There can be other outcomes of attempts to provide leadership which is too 'strong' for what society is prepared to accept. The weakened position the leaders may find themselves in may make it more difficult to provide appropriate leadership with respect to apparently unconnected issues. Since it was the Left of Blair's previously wide coalition of support which most vehemently opposed the war in Iraq, this group's hand may well have been strengthened in pursuing its other political interests (e.g. rejecting reform of public services, nuclear energy etc.). It would also seem likely that to move too soon on a controversial issue (before a sufficiently robust coalition had been built) would be to risk making it even more difficult to achieve a satisfactory outcome in due course.

4. POLITICS AND SCIENCE OUT OF STEP

As the 1970s and 1980s proceeded the relationship between science and politicians itself began to break down, changing from one of overt mutual support to one of coolness or, in some cases, antipathy. As anti-industrial activists and their sympathizers made strides into political structures (since 1990 Greens have at various times been in coalition governments or held the balance of power in France, Italy, Germany, Belgium, Finland and Sweden), so attempts were made by various pressure groups to undermine the influence of scientific expertise and to replace it with the pronouncements of activists and pressure groups who claimed (with dubious justification) to reflect the 'real' feelings of society better than elected politicians or unelected advisers from commercial interest groups.[26] This attack was made the more pointed by a growing wish on the part of opponents of nuclear energy to connect that issue in the public and political mind to that of nuclear weapons.

The schism was all the easier to achieve because of a fundamental misunderstanding between politician and scientist as to what the other was about.

Despite frequent claims to the contrary in the media, neither 'politicians' nor 'scientists' – insofar as any individual can neatly be described by such a label – are generally ill

[26] This is not to say that the Greens are uninterested in science if it supports their viewpoint. However, in general the leaders of the Green movement hold a broadly Nietzschian attitude to the truth – what is true is what is useful. (In *Die Fröhliche Wissenschaft* (*The Gay Science*, 1882/1887), Nietzsche claims that untruths can be just as useful as truths and makes a suggestion that the will not to be deceived could itself be seen as a will hostile to life, given that life itself is a matter of deception and error. These thoughts lie deep in some strands of Green philosophy.) It should be noted, however, that there are many within the Green movement who, honourably, do change their views as new evidence becomes available – there have been a number of high-profile 'converts' to nuclear energy in recent years and some environmentalists challenge the movement's focus on very small risks at the potential risk of diluting action against major threats such as water shortages or climate change.

intentioned. Both, in their own way, seek to apply some concept of 'truth' to the development of policy, with the belief that embedding this truth will lead to an improvement in human conditions. This is not to say that individuals within either culture are incapable of partiality or of bending the detail to 'clarify' the bigger picture (or even, in a small number of cases, of corruption) but, however clearly it may appear to the contrary at times, politicians and scientists are people and share a large number of features with the population at large. Indeed it is unlikely that any single individual acts in 'scientific' or 'political' mode all of the time and of course many in each culture do not conform to the picture to be painted here.

Nonetheless, there are important differences in the basic mindsets of the politician and the scientist which can lead to mutual misunderstanding. The scientist, again contrary to the popular view, inhabits a region of unremitting uncertainty. The phrase 'scientific fact' is near to oxymoron. Far from living in a world of facts, scientists ultimately live in a world of intuition which is ultimately a form of guesswork, however well informed that guesswork may be. At least in theory (and very largely in practice as well), science is an iterative process with no end point. Scientists collect observations, either from fieldwork or as the result of designed experiments. They then create hypotheses in an attempt to explain these observations – once more, in contrast to the popular stereotype, the formation of hypotheses often requires considerable imagination. The hypotheses lead to further predictions, so the scientists design further experiments or carry out further field studies to test these predictions. If the hypothesis stands up – i.e. if its predictions are supported by observation – then the hypothesis will not be discarded, but this is not to say it is 'proven' in the sense that a mathematical or logical proposition can be proven. It can never reach that status – all that can be said of the very best hypotheses is that they accurately predict a wide range of real observations. Strictly speaking hypotheses do not even offer 'explanations', at least in the simple way that the pioneers of the enlightenment expected and hoped they would – they are better regarded as 'models'. Of course, if the hypothesis creates predictions that are not borne out by experience then the hypothesis will have to be abandoned or modified and new observations made to determine whether any new hypothesis that may emerge is better.

One important consequence of this – one that causes vast amounts of annoyance among the public and politicians alike – is that no one, not even a scientist, can 'prove a negative'. A single validated negative observation is enough to disprove a hypothesis, while a thousand positive ones will not prove it. Suppose a European of the 16th century were asked to describe a swan. One attribute that could have been mentioned was that swans are not black. All swans in Europe at that time were white so this was a reasonable 'hypothesis'. When the Dutch landed in Australia in the 17th century, however, they discovered there a black swan. One single example of a black swan was enough to disprove the hypothesis that no swans are black. (This is not to say, of course, that the hypothesis that no swans are black has to be abandoned completely – it might be modified to 'no swans indigenous to Europe are black', for example, and in such a form it may still have considerable usefulness.)

This is of vital importance when it comes to considering complex scientific issues. Ideally, when testing a hypothesis, one would design an experiment where all other factors are kept constant except for the one which is under study. Typically one group of subjects (the 'experimental group') would be subjected to exposure to the alleged health risk in question, while a group of otherwise identical individuals (the 'control group') would not be subjected to exposure. Any difference in outcome for the two groups could

then reasonably be ascribed to the different exposure to the alleged health risk in question. However, it is clearly unethical to expose groups of human individuals to potentially serious health risks – indeed, there are even ethical questions about withholding a new treatment from a control group of patients when evaluating that treatment's effectiveness and potential side-effects. Scientists are, therefore, often forced to observe large numbers of individuals in society and make their best attempt to control for other factors – this is known as 'epidemiology'. However, the complex nature of human life means that one can never be entirely sure that all relevant factors have been controlled for during the observations. To take a relatively straightforward example, cancer rates in towns such as Bournemouth in the UK tend to be well above the national average. This cannot be taken as proving that something in the environment in Bournemouth causes cancer. It could be, for example, that there is a famous cancer hospital in Bournemouth and a number of patients live nearby on a temporary basis. Or it could be that a town like Bournemouth (by the seaside) attracts residents who have retired and cancer rates are higher in elderly people than in the population at large. A scientist would seek to compare cancer rates in Bournemouth with those of people of a similar age nationally, but this raises the possibility that some other common factor may have been missed. Correlation is not the same as causation.

However, many issues – BSE ('mad cow disease') and its development in humans; the possible link between MMR vaccination and autism; the health effects of low level radiation, both natural and man-made (e.g. the excess of leukaemias near some nuclear establishments like Sellafield in the UK); the consequences of erecting mobile phone masts or electricity pylons near people's homes; the causes and responses to foot-and-mouth outbreaks; the use of genetically modified organisms in agriculture – generally involve making sense of small numbers of data, usually gleaned from an uncontrolled environment. The best that science can hope to offer in these circumstances is to say that current understanding suggests that the pathogen in question is not (or is) a significant threat to health but that further data might lead to a reappraisal of this position. Clearly the more data that are collected the more confidence there will be in the 'best guess', but there will never be absolute certainty.

A second consequence is the impression that a scientist who holds a hypothesis which is later proven to be wrong or inadequate is *ipso facto* a fool or a knave. In fact the duty of the scientist is to try to prove him- or herself wrong by designing experiments or studies that might invalidate a current or emerging hypothesis. Newtonian mechanics is now known to be 'wrong' in the sense that it does not apply in all circumstances (and especially to systems at the atomic level) – the same can be said about atomic theory at least from Dalton to Bohr. But nobody would claim these great minds, who contributed so much towards the development of our models of matter and without whose work more recent theories could not have been created, were either stupid or dishonest.

The political mindset is almost the diametric opposite. Politicians talk (and often think) in terms of certainties. An answer hedged in if and buts is regarded as of little use in public debate – the public (and even more so the mass media) are often adept at finding questions that require a 'yes' or 'no' answer and then accusing politicians of refusing to answer – but that is the only kind of answer the scientists have to give. The difference can perhaps be caricatured in this fashion'.

- The scientist has a reasonable idea of what has happened in the past but can only make tentative and uncertain predictions about the future.

- The politician has absolute certainty about what will happen in the future (if you vote for his/her party – lots of nice things – or indeed for the other lot – lots of nasty things) but will argue until the cows come home about what happened ten years ago.

Dr Vincent Cable, who worked for Shell (and was Head of the Chatham House International Economics Programme) before entering Parliament in 1997, characterizes the difference between the political and scientific modes of operation in terms of five factors:[27]

- speed – in the political world decisions often have to be taken very quickly;
- superficiality – politicians must cover a great deal of ground (especially if they are not in a ministerial position and therefore not supported by considerable civil service resources);
- spin – in politics, perception is often the only 'reality' which counts and there is always a danger that politicians will start to 'believe their own propaganda', thereby mistaking the art of presenting figures in the most favourable light for the situation actually being rosy;
- secrecy – scientists seek to make all available facts and reasoning known so that others can comment, while in government proper public review of decisions is often impeded by restrictions on the flow of information;
- scientific ignorance – many who enter politics do not have a scientific background, perhaps because the mindsets required for the two fields of activity are so different.

The political mindset finds it especially difficult to admit to error and therefore, for example, to change an attitude merely because there is a welter of evidence showing that a particular policy does not work. The open discussion of alternative possibilities, which is the very stuff of healthy scientific discourse, is regarded with increasing horror, at least within individual political parties where any sign of straying from the party line (certainly in public) is often regarded as an act of sheer treachery. An example of the breakdown of the relationship between politicians and academia emerged in the debate about the introduction of identity cards in the UK in mid-2005. The London School of Economics (LSE) published a 300-page report which, *inter alia*, questioned some of the government's assumptions on the costs of the scheme. According to the Director of the LSE:

> Home Office officials demanded to see advance copies. Before they had been provided, the Home Secretary condemned the cost estimates as 'mad'. When it was published, he described the analysis as a 'fabrication' and one of the project mentors as 'highly partisan'. It is unfortunate that the government chose to adopt a bullying approach to critics whose prime motivation was to devise a scheme which might work, at an acceptable cost.[28]

(Interestingly, the government was later to back down on some of its claims for identity cards, junior minister Tony McNulty saying:

[27] http://www.odi.org.uk/RAPID/Meetings/Evidence/Presentation_3/Cable.html, V. Cable, *Does Evidence Matter? The Political Context*, Overseas Development Institute, 2003.
[28] http://www.timesonline.co.uk/newspaper/0,,2719-1677135,00.html, H. Davies, 'LSE report on ID cards cost' (letter), *The Times* (2 July 2005).

> Perhaps in the past the government, in its enthusiasm, oversold the advantages of identity cards. We did suggest, or at least implied, that they might well be a panacea for identity fraud, for benefit fraud, terrorism, entitlement and access to public services. In our enthusiasm we over-emphasised these benefits.

However, it was stressed that the scheme would go ahead[29].

Some commentators, notably Thomas Kuhn, have argued that in practice science proceeds in ways highly reminiscent of the political process. Certain theories become 'accepted wisdom' and are associated with major scientific figures of the day. When evidence becomes available to challenge this accepted wisdom, often the first response of the scientific establishment is to reject this evidence and even to attack the integrity of those who have discovered it. If, after a period of warfare between different factions, such a welter of evidence becomes available that the accepted wisdom is no longer tenable, a 'paradigm shift' may occur whereby a new view becomes accepted very rapidly. Those who were until recently seen as rebels now become the new priesthood, until such a time as their own theories begin to be challenged and a new period of warfare breaks out. Einstein, for example, vehemently rejected Heisenberg's Uncertainty Principle, saying 'God does not play dice with the universe'.[30] From a less charitable standpoint still, there have certainly been examples of scientists succumbing to pressure to alter their findings or keep them quiet if they do not serve the interests of the sponsor. However, influential though Kuhn's work has been it does not seek to overturn the view that 'good' science, through its ultimate recourse to experiment and observation, does proceed in a different way from other avenues of discovery.

Unsurprisingly, two such mindsets do not always fit together well. In a satirical context, Lynn and Jay (1982) make an interesting observation, one which might be recognized by people working in a range of different industries:

> There are times in a politician's life when he is obliged to take the wrong decision. Wrong economically, wrong industrially, wrong by any standards – except one. It is a curious fact that something which is wrong from every other point of view can be right politically. And something which is right politically does not simply mean that it's the way to get the votes – which it is – but also, if a policy gets the votes, then it can be argued that that policy is what the people want. And, in a democracy, how can a thing be wrong if it is what the people will vote for?[31]

The opposite can also be the case. When in 1988 UK Health Minister Edwina Currie said that, 'Most of the egg production in this country, sadly, is now affected with salmonella', she was forced to resign, not because of the substance of her claim (which was fundamentally accurate)[32] but because of the political damage done by the unguarded way in which it was made.

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[29] http://news.bbc.co.uk/1/hi/uk_politics/4744153.stm, 'Labour admits ID cards oversell', *BBC News Online* (4 August 2005).
[30] http://www.marxists.org/reference/subject/philosophy/works/us/kuhn.htm, T.S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962.
[31] J. Lynn and A. Jay, *Yes, Minister* Volume 2, BBC Books, London, 1982.
[32] http://millennium-debate.org/tel26dec015.htm, D. Millward, 'Currie "was right" on salmonella', *Daily Telegraph* (26 December 2001).

The scientist equivocates, not to avoid responsibility but because, when dealing with precisely the public issues which are of most interest to politicians and the public, the available data often do not allow anything approaching a clear answer. But the politicians and the media, so often coming from non-scientific backgrounds, believe science is about 'facts', not least because that is the way it seems to be taught in many British schools (one of the strongest reasons for including the teaching of a questioning attitude alongside the teaching of 'facts'). The apparent reliability of some observations is confused with the inherent unreliability of hypotheses based upon them.

Some practical implications of this disparity in values are explored later. However, one particular topic in which the difference between the political and the scientific mindsets is important is in the perception and management of risk.

In the developed world, life today is a much less risky business, day-to-day, than is the historical or geographical norm.

> The world has become a terrifyingly safe place. Clean, healthy, predictable, relatively crime-free, children don't die much, most people live to a ripe old age, journeys are no longer a dangerous adventure, epidemics don't sweep us away – life is dull, dull, dull.[33]

Yet societal concerns about low levels of risk run at a high level, most notably in periods when there seem to be few external threats.

> How extraordinary! The richest, longest lived, best protected, most resourceful civilisation, with the highest degree of insight into its own technology, is on its way to becoming the most frightened.[34]

It seems that many of us live at our own level of anxiety and unhappiness whatever the external environment, finding aspects of the world on which to focus these concerns.

> All willing springs from lack, from deficiency, and thus from suffering. Fulfilment brings this to an end; yet for one wish that is fulfilled there remain at least ten that are denied. Further, desiring lasts a long time, demands and requests go on to infinity; fulfilment is short and meted out sparingly. But even the final satisfaction itself is only apparent; the wish fulfilled at once makes way for a new one. No attained object of willing can give a satisfaction that lasts and no longer declines; but it is always like the alms thrown to a beggar, which reprieves him today so that his misery may be prolonged till tomorrow. Therefore, so long as we are given up to the throng of desires with its constant hopes and fears we never obtain lasting happiness or peace.[35]

Indeed, paradoxically we can appear unhappier, as societies and individuals, when life is going well than when some external threat binds us together. It is often observed that suicide rates and industrial disputes, for example, fall during wartime and some people of the era claim that the years of the Second World War were among their happiest.

[33] http://members.fortunecity.com/templarser/toynbee4.html, P. Toynbee, *RadioTimes,* 2000.
[34] A. Wildavsky, 'No risk is the highest risk of all', *American Scientist* Jan.–Feb. 1979: 67.
[35] A. Schopenhauer (1819), tr. E. Payne, *The World as Will and Representation* (Volume 1), Dover Books.

Perhaps at times of stress there are perceptions that things can get better if certain strong actions are taken, so we work together to get there. (As Schopenhauer recognizes, it is patently not the case that our anxiety levels are precisely the same on a moment-by-moment basis or even over longer time periods. We all feel elated or crushed by particular events and the euphoria or devastation can go on for a long time – a very long time in the case of grief, say – before we return to our personal equilibrium point.) The anxiety we feel when things go well is a different type – more diffuse, less focused on particular risk stimuli, and therefore not apparently amenable to collective remedial action. So we end up focused on the particular (alleged) victims of relatively trivial risks such as phone masts without the same hope that we can do anything very significant to improve matters.

This causes the politician real difficulties. If people are anxious even when things are going well, the politician must respond publicly to these anxieties, however badly they may be founded. Politicians frequently respond to this ongoing (and superficially puzzling) level of public anxiety by asking scientists whether a particular activity is safe. It seems, however, that when a politician asks if something is 'safe' they are really asking for a scientist to offer proof of a negative – that there are no potential public health consequences – while the scientist hears the question in a quite different way, responding along the lines that 'as far as can be told at this time given the state of observation and bearing in mind that there may be a gap between being exposed to the potential risk and consequences appearing, the risk associated with the activity seems to be extremely low'. The politician just hears the word 'yes' (media commentators, in particular, force the scientist into responding 'yes' or 'no' and get very cross if the scientist continues to prevaricate). It follows that, should just one example emerge of an adverse effect which can plausibly be ascribed to one of these 'safe' activities, then not only are the particular scientists who were interpreted as giving the activity a clean bill of health vilified, but the whole idea of 'science' as being a useful tool in addressing similar issues is undermined.[36]

> 'Why do you experts always think you are right?', I enquired coldly.
> 'Why do you think', countered Sir Wally emotionally, 'that the more *in*expert you are, the more likely you are to be right[37]?'

The way that technical expertise is being replaced by other influences when it comes to decision-making with reference to other major public controversies is discussed later. However, Worcester's comment – 'it is unlikely that the blind faith in the men in white coats will return'[38] – is probably true.

In reality, politicians who are well served by officials do carry out risk management and are increasingly being encouraged to do so by bodies such as the Audit Commission.[39]

[36] In the author's role as Chairman on the Education Committee of a local authority, he once received a letter from the local Green Party which claimed that 'the same scientists who said Chernobyl could not happen are now saying the Genetically Modified Organisms are safe'. Further enquiry failed to elicit the names of the scientists in question.
[37] Exchange between Rt Hon. Jim Hacker MP and Sir Wally McFarlane, Chairman of the fictional British Chemical Corporation, Lynn and Jay, *Yes, Minister* Volume 2.
[38] R. Worcester, *Science and Society: What Scientists and the Public can Learn from Each Other*, MORI, 2001.
[39] http://www.audit-commission.gov.uk/reports/MANAGEMENT-PAPER.asp?CategoryID=&ProdID=ECBCFDA5-BD87-4f09-8A13-FB0E0246B282, Audit Commission, *Worth the Risk*, 2001.

However, in practice some politicians go to extraordinary lengths to conceal their involvement in risk management from their electors, presumably because this could be interpreted (and almost certainly would be interpreted by political opponents) as indicating weakness or a lack of sureness of touch. 'In government you must always try to do the right thing, but whatever you do, you must never let anyone catch you doing it'.[40] The political instinct to act firmly without expending too much effort on getting to grips with the uncertainty inherent in so many real-world situations seems to be a very strong one.

5. LESSONS FROM OTHER CONTROVERSIAL SCIENTIFIC/POLITICAL ISSUES

It is a matter of fascinating but largely irresolvable speculation as to whether the phenomenon of the rejection of (or at least widespread opposition to) new technologies is a recent phenomenon. For example, if air travel had been invented more recently, would the combination of potentially catastrophic disaster (a large aircraft suffering failure over a densely populated city) and the unproven safety record have prevented the whole industry 'taking off'? The piping of explosive gas under and into our homes, coupled as it is with the occasional fatal disaster, would seem on the face of it to be worthy of rather more concern than some of the above issues.[41] Similarly, the dangers associated with smoking (including passive effects), one suspects, would have resulted in its being declared illegal, like other drugs which are illegal today but whose effects do not seem to be as severe or well-established.

> If aspirin was to be invented now, it would probably be refused a licence because of all the side effects it has, even though it has proven to be a highly successful and effective drug.[42]

Be this as it may, however, recent years have been punctuated by a series of issues in which the best available scientific information has been rejected by the public and subsequently by government when it comes to formulating suitable policy. A few cases are considered in Appendix 2.

While each example has its own unique features, a number of common themes emerge from a study of such disputes, at least in countries such as the UK.

- Problems often arise in fields where the activity in question is alleged to have severe effects on a very small number of individuals but where epidemiology, the study of the distribution of the disease among various populations, is unable to say whether the activity and the alleged outcome are linked.

[40] Lynn and Jay, *Yes, Minister* Volume 3, BBC Books, London, 1983.

[41] In 1997 an Anglo-Irish company, Pacific, bought a 400 sq. km former Ministry of Defence base at Trecwn, Wales. The company subsequently announced it wanted to use part of the site to store nuclear material (fuel rod cladding and isotopes used in medicine), claiming it would be quite safe in the labyrinth of tunnels up to 5 km deep that once formed the largest underground munitions depot in Europe. (The tunnels had been built during the Second World War and at one time held 4,000 tonnes of high explosives.) Local campaigners, who had seemed quite sanguine about the tunnels storing high explosives, were up in arms about the proposals to store materials that by any estimation could not be regarded as being anything like as hazardous.

[42] H. Meldrum, British Medical Association, 'There is no such thing as a 100 per cent safe drug', *Independent* (22 August 2005).

- Often the activity in question has a clear benefit for society but there may be apparent alternatives available.
- Public concern about the issue in question often emerges rapidly and unexpectedly – there seems no reliable way to predict when an issue will blow up in the public mind and the political and scientific establishments are often caught unaware.
- Initial attempts to dismiss these concerns may lead to growing dissatisfaction with the government's response among a relatively small number of highly vocal activists.
- The activists usually point to a small number of named alleged victims to counter the more statistical approach of the scientific establishment, serving to make the scientists appear more interested with numbers than real people.
- Politicians ask scientists for black-and-white answers to questions such as 'is it [whatever the 'it' might be] safe?'
- However, scientists are unable to answer unequivocally, first because of different conceptions of the word 'safe' – for the scientists nothing is entirely risk-free so a yes-no answer would be meaningless – and secondly because data are often scarce, so preventing firm conclusions about the likelihood of harm.
- Governments therefore set up 'expert' committees to give credibility to the claims that the activity is harmless, sometimes at the same time as wide-ranging 'interim' restrictions are announced on the activity in question (presumably in the hope that this would allay public fears).
- However, the technical expertise of the committee is generally diluted, both through its membership and through its terms of reference, by the perceived benefit of including lay members representing various pressure groups.
- The committee, when it reports, is unable to give the activity a clean bill of health, both because of the personal agenda of some of its members and because science is unable to give unequivocal answers to such questions.
- Politicians are left with the choice of supporting the activity despite the equivocation of the expert committee, or of continued vacillation and, in effect, erection of further barriers against the activity (perhaps invoking the 'precautionary principle'), whatever its benefits might be.
- In either case, the public is left with a feeling that something is wrong that was not detected at the start of the process. This serves to exacerbate mistrust in politicians and scientists alike and give extra impetus to the next such issue to appear on the public stage.
- The economics of the activity are adversely affected by the uncertainty over regulation and governmental action.

The debate about radiation and nuclear energy (both new build and waste management) has largely followed this pattern. However, the high initial costs and the consequent very long timescales involved in nuclear investment make such uncertainty particular damaging to new nuclear projects.

6. A DEVELOPING COUNTRY PERSPECTIVE

This paper has focused on developed countries, where generally speaking the economies tend to be growing at a modest rate (a few per cent per year) and energy demand more slowly owing to ongoing improvements in energy efficiency (or reductions in energy intensity). From an energy standpoint the focus in such countries tends to be on replacement for existing plants. Looking more widely, when such countries are going through a 'comfortable phase' there is often a resistance to new technologies – if life is going 'well enough' then why take the (perceived) risks associated with mobile phone masts, low level radiation or even vaccination?[43] Indeed, in some countries it seems that people now take for granted the benefits of industry and science, to the extent that they find it difficult or impossible to imagine life without them. If there is a subconscious assumption that these benefits will always be available – for example, that prolonged and widespread power outages are impossible in developed countries – then it is likely that people will focus on the downsides of the technologies in question rather than making a more balanced cost-benefit analysis.

It is of course a mistake to view the developing and newly industrialised world as in any sense a homogeneous group of nations. One can find at least as many differences within this group as one can in the developed world. Nonetheless, one can speculate that certain characteristics of many developing economies have systematic effects on the relationships between science/technology, politics and the people.

- The imperative for economic growth tends to result in most elements of society viewing industrialization, science and technology as major benefits to their way of life.
- Since there are more severe challenges in everyday life, people's need to feel anxious, even if it is as great as that of people in developed countries, is more likely to be fulfilled by matters such as hunger, poverty, the need for education and health care etc.
- Levels of literacy are lower in some cases than in developed countries and the penetration of the Internet less ubiquitous, with the result that members of the public are less able to participate in major debates of the day.
- The opportunities for well-paid employment associated with many scientific and (particularly) industrial activities are more valued in poorer countries. In the developed world many countries have seen a decline in their manufacturing sector (to the benefit of service industries) while many of the companies involved have relocated to less affluent countries.
- The desire for many developing and newly industrialized nations to demonstrate that they are as advanced as developed countries has led to a similar attitude towards science and technology, especially at the high-tech end, as was seen in developed countries in the post-war years.

As a result it may be possible to regard the attitudes of governments and people in some developing countries as similar to those which pertained in what is now the developed world at the same point in its history. The investment in nuclear energy in China, India and South Korea, for example, is highly reminiscent of the early support given to the industry in the USA and Western Europe. It would seem possible, then, that politicians in these countries, as their economies develop, may find themselves facing similar pressures to those facing their counterparts in the developed world.

[43] http://news.bbc.co.uk/1/hi/health/2803601.stm , 'Measles cases soar', *BBC News* (27 September 2003).

7. A CRITIQUE OF DECISION-MAKING IN A RIGHTS-BASED ETHICAL CONTEXT

It is difficult to argue that a society in which individual citizens have a better opportunity to engage in debate and to challenge those responsible for making or advising on decisions is a retrograde step. However, the often-heard plea among protagonists in complex issues – that they must 'educate the public' so that they will come to the right conclusion (and therefore allow or even force politicians to take the right decisions) – is unconvincing.

First, one person's unbiased information is another's propaganda. The very concept of an 'independent' commentator is flawed – everyone has vested interests, be they towards their own reputation, their sense of moral superiority, their religion or quasi-religion, their employer, their political party or any one of many other possibilities. It is interesting to note that in a dispute such as the use of nuclear energy both 'sides' are passionate in their desire for public education and are highly frustrated at the ill-informed attitude of the population at large. 'If only they understood the real issues they would stop worrying/worry a lot more about radiation/vaccination /genetic modification/BSE prions/phone masts …'

One possible solution to this tension might be if society could agree on some kind of 'information ombudsman' who would act as an arbiter of balanced information. This might be a body such as the European Union's Joint Research Centre,[44] which is developing a strong reputation for neutrality and whose mission is:

> to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

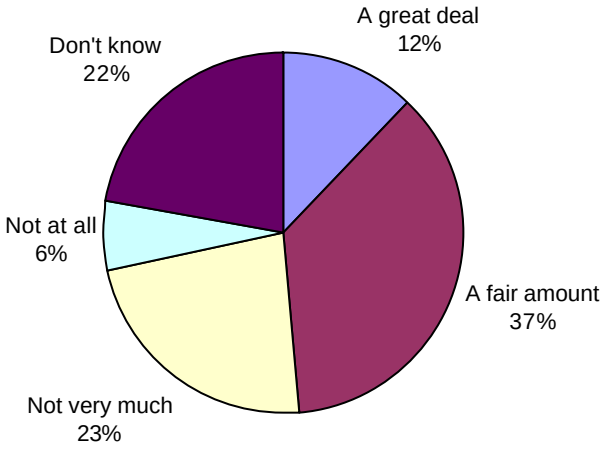
However, experience of the criticism heaped on official regulators and advisory bodies by those who hold extreme views suggests that controversy would continue. In any case the existence of such a body would not change the fact that both the 'professional' supporters and opponents of a technology such as nuclear energy are often extremely well informed, or that even when the facts are not seriously in dispute diametrically opposed conclusions can be drawn. (One obvious example is the Three Mile Island accident in 1979, cited by opponents of nuclear energy as powerful evidence of the inherent dangers of the technology and by supporters as demonstrating that even in the event of a major accident, releases of radioactive materials were very limited and nobody was hurt, a tribute to the inherent safety of nuclear energy.) In fact, the evidence that increasing levels of technical understanding of an issue such as nuclear energy leads to a greater acceptance of the technology involved is weak – supporters of nuclear energy within the general population do not seem to be significantly better informed about the issues than opponents.

This being said, a basic level of awareness of the wider issues would seem to be required to allow citizens to participate meaningfully in such debates. From this

[44] http://www.jrc.cec.eu.int/default.asp@sidsz=who_we_are.htm, DG Joint Research Centre website.

standpoint evidence of the level of understanding of some fundamental issues is of concern. In a MORI poll of 2002, when asked 'To what extent do you believe the statement that, unlike fossil fuel power stations, nuclear power stations do not produce the greenhouse gases that contribute to global warming?', fewer than half of the sample said they believed it (see Figure 3).[45]

Figure 3: Responses to question: 'To what extent do you believe the statement that, unlike fossil fuel power stations, nuclear power stations do not produce the greenhouse gases that contribute to global warming?'

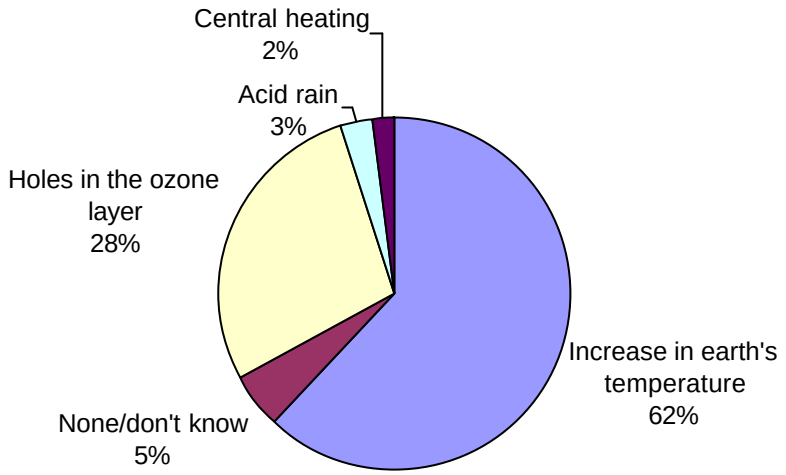


Similarly, as Figure 4 shows, understanding of issues such as global warming is not universal, with over one-third of respondents unable to pick the correct description from a short list.

However, to expect a highly sophisticated level of public debate leads us to a second difficulty. Each of us only has a certain amount of mental 'space' to devote to issues of complex scientific controversy. There may be individuals who can claim to be experts in each one of the dozen or more complex issues that we might identify, but if so they are extremely rare. Why should any individual without a direct personal or professional interest in the nuclear debate, say, choose to immerse themselves in this rather than in MMR, BSE, phone masts, genetically modified organisms, road building or any one of the other issues on offer? Society simply cannot move forward on the basis of all, or perhaps even any, of its citizens being fully engaged in all such debates. Somehow a way forward has to be found which can command support among the vast majority who will not be well acquainted with the fine details of every issue. Of course, a more widespread understanding of what science is really about would help in all cases but would not alter the need for each of us to accept somebody else's appraisal of many complex issues.

[45] http://www.niauk.org/energychoices2004/Robert_Knigh.pdf, R. Knight, *What Do the Polls Tell Us? Public and MPs' Attitudes to Nuclear Energy,* MORI Reputation Centre, 2004.

Figure 4: Responses to question 'What do you understand by the term "global warming"'?



If the decline of blind deference, then, becomes a rejection of informed advice – 'never trust an expert', as environmental activist Amory Lovins once put it – then it is likely that the quality of decision-making will suffer. As a thoroughgoing utilitarian might argue, if we follow the best available scientific interpretation in pursuing a dozen issues of the above kind then it is likely that, in one or two cases, events may show that the best available scientific interpretation underestimated the risks. Nonetheless, society might well be significantly better off than if all twelve issues had been abandoned at an early stage or if the prejudices of those motivated by more mystical or obscure sources of belief had been given hegemony.

Examples such as the cases discussed above may suggest that the more recent approach of creating panels with membership from widely differing and (in all likelihood) irreconcilable viewpoints on a matter of dispute and asking them to reach agreement may be collapsing. Such groups seem either to produce 'consensus' reports which are too vague to be of use in decision-making or to dissolve in dispute between the technical and social/political elements, coming as they often do from different ethical standpoints.

However, this observation merely restates the difficulty faced by politicians at various times in history. To resolve the nuclear waste issue in a long-term sense requires a firm decision – even if that decision is to repackage the waste at its current location this would presumably involve some local objection among people who had assumed it would eventually go to a national repository as the industry had implied. But if society is in a mode in which strong decision-making is generally unpopular, requiring as it inevitably would some kind of costs for some people, then the temptation for politicians may well be to resort to perpetual consultation, research and review, in the hope that the problem will dissolve (or at least retreat until they are out of office). The wider the

consultation the more the politicians can demonstrate that they are taking the issue seriously and the less likely is resolution.

Timescales

One could argue that none of this really matters. Society could sail along at times of prosperity with politicians keeping a steady hand on the tiller, tinkering with perceived problems but making no dramatic gestures of the kind seen in 1945 or 1979. If and when major threats emerge to this complacency, either incumbent politicians or (more likely) a new radical generation can be elected to exercise 'strong leadership' and take the country in a new direction.

It is here, however, that the mismatch between the timescales on which the political and investment cycles work becomes particularly serious. A new nuclear power station, gas pipeline or LNG import facility, large wind farm or tidal barrage project cannot be completed overnight or even before the next election – it is a long and often tortuous process to get the necessary planning permissions, arrange finance and build the plant in question. For example, the utilities funding Olkiluoto-3 in Finland made a final decision to apply to build the plant in 1998, after some years of feasibility and financial studies. The application was lodged in 2000, parliamentary approval was granted via a decision-in-principle in 2002 (by a vote of 107-92, almost a precise reversal of the previous vote in 1993), construction began in 2004 and commercial operation is expected in 2009.

It is possible to identify at least four sets of timescales, existing in considerable mutual tension.

Crises within the energy field can develop rapidly. The world oil price trebled between mid-1999 and mid-2000 and almost doubled again between mid-2004 and mid-2005 (see Figure 5); the electricity shortages in California in 2000-01 appeared quite suddenly; the blockade of transportation fuel refineries caused by protests in much of Europe in September 2000 took barely a week to bring the economy to a virtual standstill; 9/11 may well have profoundly changed some aspects of the world with respect to energy provision – the security of oil supplies, the dangers of terrorist attacks on energy installations such as nuclear stations or large power dams; major blackouts such as those which occurred in Italy in 2003 can change perceptions in a single day. (It should be noted, however, that even large-scale changes, real or perceived, are often reversed, sometimes just as quickly.)

Figure 5: Brent crude oil price (US$ per barrel), 2004–05[46]

The political cycle is relatively short – typically four or five years between general elections, of which in the modern political world at least two years can be regarded as the 'election campaign'. (Furthermore, there are other political cycles, notably those involving local government, which tend not to be synchronised with national elections but which can have profound implications for implementing national policy in a particular location.) Even when one party or coalition seems well ensconced, a change of power is always possible and all politicians must always have at least one eye on the electoral implications of their policies.

The investment cycle might be of the order of a decade. Its length is to a considerable degree dependent on the particular market structure. In competitive power markets investors generally prefer a 'quick' return in order to minimize economic risk (which inevitably tends to increase as timescales lengthen).

Finally, the timescales involved in making major changes to the energy industry can be much longer, frequently being measured in decades at least. There is often a long period between the emergence of a new concept or technology and its availability for commercial exploitation. In some industrialized countries a decision taken today to build a nuclear power station might be followed by up to a decade of planning and regulatory activity, a construction phase lasting five or six years and fifty years of operation. The installation of a new gas pipeline, or major hydropower or tidal facility, might have similar time horizons.

One common outcome of a failure to recognize these different timescales and their implications is a confusion between short-term, cyclical crises and long-term problems requiring long-term solutions. Typical a crisis will arise – in Europe around the turn of the century, for example, a combination of a major increase in the oil price, the petrol protests which brought a number of European countries to a virtual standstill within a week in September 2000 and significant power cuts in California and Victoria – and government responds by launching a major energy review like the British one announced immediately after the 2001 general election. However, by the time the report is ready the short-term crisis has usually resolved itself – in this case the oil price had fallen, attempts to repeat the petrol blockades had failed and secure supplies had returned in California. The report which emerges, then, tends to find that there is no

[46] http://newsvote.bbc.co.uk/1/shared/fds/hi/business/market_data/commodities/28696/twelve_month.stm, BBC website (accessed 30 September 2005).

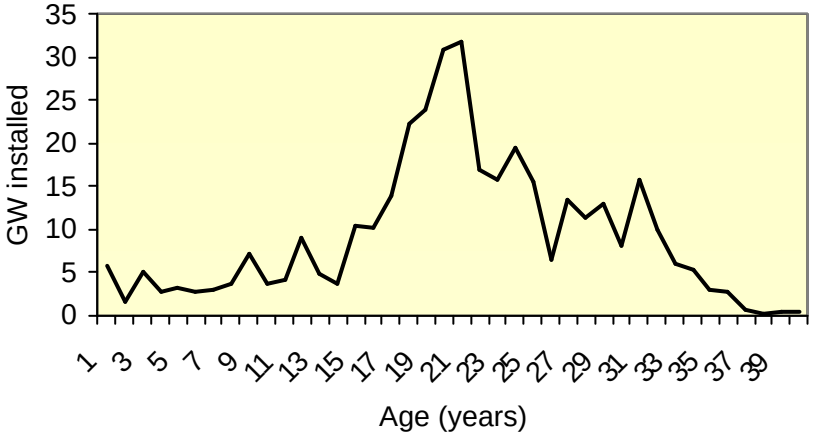
need for panic or decisive action because the problem has gone away. (The UK Performance and Innovation Unit report was regarded by many commentators as being unduly complacent.)

But just as it is a mistake to interpret a short-term problem as the 'beginning of the end' – despite the action of vested interests that tend to over-exaggerate the implications in their call for immediate and radical action and hence ultimately play into the hands of the 'do-nothing' brigade – so it is wrong to believe that a short-term easing of the situation means the long-term issues have been resolved.

The conclusion is difficult to escape – politicians must find a way of pursuing policies that will head off the long-term problems, because by the time these problems are established to everyone's satisfaction it may be too late to do anything very effective about them. This could well mean they have to act as 'strong leaders' and force through controversial projects at a time when society, still feeling comfortable and not perceiving the precipice they are approaching, is not inclined to accept such leadership.

The disparity among the various timescales is perhaps an especially important issue in the case of nuclear power. The age profile of worldwide nuclear power capacity is a striking one – some 84 per cent of global nuclear capacity is fifteen years old or more (see Figure 6). If the average lifetime of a nuclear power reactor is taken to be forty years, then more than one-third of present installed capacity will come to the end of its operational life by 2020 and a further 50 per cent between 2020 and 2030. Even if all projects described as 'under construction' as of March 2005 are completed, this will add only a further 16,500 MW, giving a total of about 70,000 MW in operation in 2030 (assuming some life extension). This is a mere 20 per cent of current installed nuclear capacity.

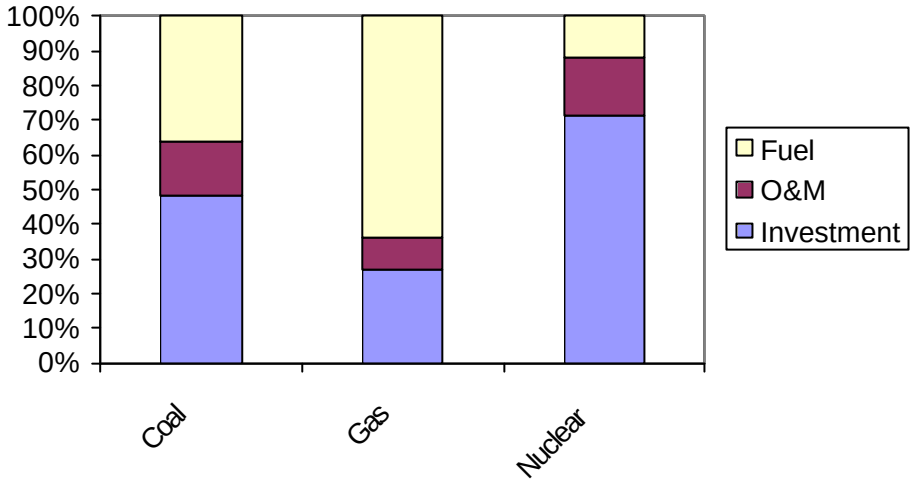
Figure 6: Capacity of global installed nuclear capacity by age (2005)



The 'lost' 80 per cent of this capacity will have to be replaced. To replace it with more nuclear capacity will be a lengthy task, since the period between ordering a new plant and its starting to generate electricity can be a decade or more.

Competitive electricity markets tend to exacerbate the difficulties of investing in nuclear energy. (Almost all existing nuclear capacity was built against the background of centralized electricity supply systems but most of it now operates in markets which are at least nominally 'competitive' to some degree.) Recent calculations suggest that the 'levelized' costs of nuclear-generated electricity – i.e. the average cost per unit over the lifetime of the plant – compare favourably with those of other major fuel sources, even at discount rates as high as 10 per cent (see Figure 7).[47] However, a higher proportion of the nuclear costs is accounted for by investment costs, with operation and maintenance (O&M) and fuel costs being correspondingly less important.

Figure 7: Cost profile for sources of electricity (10% discount rate)



This delivers certain advantages, notably a considerable resistance to fuel price inflation when compared to gas or coal-fired plants. However, investment in traditional very large nuclear plants is relatively inflexible and irreversible. In competitive markets there is a considerable advantage in being able to change the mix of fuels being used for power generation as rapidly as possible to respond to changes in market conditions. The large investment necessary to build a traditional nuclear plant (or other large project) in effect ties the operator to the technology to a much greater extent than would be the case with, say, a relatively small-scale gas-fired plant. Yet reductions in the costs of nuclear investment may be highly dependent on the ordering of series of four, six or even eight plants. The trade-off between costs and flexibility is an awkward one for large plants of any description and perhaps traditional nuclear reactors in particular.

Development of modular approaches to nuclear power generation, based on much smaller units, may help to address this issue, but it seems unlikely that a nuclear design which can compete with CCGT in terms of initial investment costs per kW installed will be available in the foreseeable future. For large nuclear plants to be attractive to investors there will need to be a long-term framework which, if not closely resembling the former 'command-and-control' model of electricity supply systems (a monopoly generator with captive consumers), must nonetheless offer the prospect of a stable and

[47] OECD/NEA, *Projected Costs of Generating Electricity – 2005 Update* , OECD, Paris, 2005.

generally supportive investment environment that will last for several decades, a period of time that represents an enormous challenge to the timescales of political life.

8. WHAT POLITICAL SUPPORT IS NEEDED TO UNDERPIN NEW BUILD?

So what political support will be required to create such an environment?

Part of the commitment would be a firm set of statements in favour of nuclear energy. It has long been assumed that the very act of making public comments supporting nuclear technology would be risky, but in reality it may not be as politically 'courageous' as it might first appear. Opinion polling carried out by MORI[48] in the UK suggests an interesting pattern of perceptions about public perceptions among opinion-formers and decision-takers (see Table 1 and Figure 8).

Table 1: Perceptions of public opinion on nuclear energy industry

	Favourable towards nuclear energy industry (%)	Unfavourable towards nuclear energy industry (%)	Neither favourable nor unfavourable/don't know (%)
Public opinion	28	25	47
All MPs	43	44	13
MPs' perception of national public opinion	2	84	14

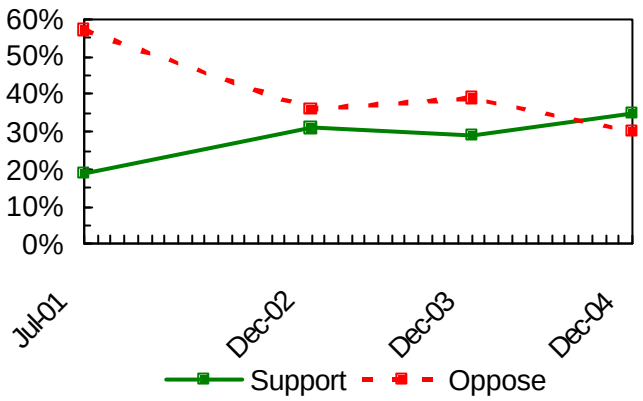
A similar pattern has been observed in the USA. These data imply that, at least in some countries, the perception of public opinion among decision-makers may not be accurate. Possible reasons include the attitude of certain elements of the popular media and the greater effectiveness of anti-nuclear pressure groups in organizing letter-writing and other publicity campaigns.

In Western Europe new nuclear stations, at least in the first instance, are likely to be built mainly on sites which play host to reactors at present. Public opinion in these areas tends to be among the most pro-nuclear, as local people are familiar with the technology and often earn their livelihood from it. (The 'fear of the unknown' is also less in these areas.) Public opinion in many developed countries, including those with formal phase-out policies, showed a significant pro-nuclear shift in the early years of the new century.

A clear statement of support, especially if it carries a degree of cross-party consensus, is likely to have beneficial effects on the market's perception of the economic risks associated with funding new build, with corresponding reductions in the cost of capital (i.e. required rate of return).

[48] BNFL, *MORI UK Opinion Poll Findings*, BNFL, Warrington, Cheshire, 1999.

Figure 8: Responses to the question, 'To what extent would you support or oppose the building of new nuclear power stations in Britain to replace those which are being phased out over the next few years? This would ensure the same proportion of nuclear energy is retained.'[49]



However, protestations of support, important as they are, may not be enough when it comes to encouraging new build. It can be argued that nuclear energy could prosper in two distinct political environments,[50] assuming no return to the previous 'command-and-control' model of organizing the electricity supply industry. In the first, government would intervene in the marketplace to ensure that nuclear energy, or perhaps more cogently 'zero-carbon electricity sources', will flourish. The crudest way of doing this, one which sits ill with the liberalized marketplaces of so many developed countries, would be for the government simply to build and perhaps operate nuclear power stations. More feasibly, governments might extend to new nuclear build the range of incentives being offered to renewables, e.g. in terms of reserved market shares (as instituted in the UK) or of high guaranteed prices (e.g. in Germany).

Alternatively, government could take a studiedly non-interventionist approach to the electricity market, recognizing price spikes and periods of high price as necessary to attract new investment when it is required. This stance could be made bankable by offering investors an indemnity against future regulatory changes which might affect the profitability of their investment (or even force its closure) through no fault of their own. President Bush moved in this direction when he announced steps to reduce risk and uncertainty in the licensing process for new build, including a call for the Department of Energy to provide risk insurance to mitigate the additional cost of unforeseen delays.[51]

The problems arise where governments appear to be treating energy as a commodity, by setting up competitive markets, but then continually intervene (in effect treating energy as a social or industrial service). In 1998 in the UK, for example, then Trade Secretary Peter Mandelson introduced a moratorium on connection of new gas-fired capacity to the system, a measure that was abandoned some two years later by his successor, Stephen Byers. Such capricious interference in the working of the market

[49] http://www.niauk.org/energychoices2004/Robert_Knigh.pdf, Knight, *What Do the Polls Tell Us?*
[50] See M. Grimston (forthcoming), *Too Much, Too Little or Too Late? The Confusion at the Heart of Energy Liberalisation Policy*, Centre for Policy Studies.
[51] http://www.usembassy.org.uk/eande097.html, US Embassy, London, *White House outlines Bush energy proposals* (27 April 2005).

causes a general loss of confidence in investment, but it is particularly a problem for a heavily capital-intensive project such as a new nuclear power station. The extreme case of Shoreham has been discussed above – to lose an entire nuclear investment is more severe than losing a gas-fired project of the same size, since the latter involves much lower initial outlay.

Measures of this nature – either significant overt intervention or a guarantee *not* to intervene – require considerable political commitment. (In the former case it would involve committing taxpayers' money or interfering in market structures, while in the latter case it might mean ignoring the cries of pensioners whose bills have rocketed at the times of high power prices necessary to signal new investment.) It is unlikely that a series of 'consensus' committees, driven by social rather than technical considerations, will be able to substitute for this political commitment.

Furthermore, they require a degree of cross-party consensus. Part of the success of the Scandinavian programmes to develop radioactive waste disposal sites has derived from the relative harmony among political parties. In other countries, notably those which have introduced moratoria or have closed plants early for non-economic reasons (Austria, Italy, Sweden, Germany), a potential investor will be interested not only in the stance of the present government but also in that of potential alternative governments for many years into the future. The same applies to other capital-intensive energy sources – the defeat of the SPD in the North Rhine/Westphalia elections in May 2005 were accompanied by falls in the share price of companies involved in wind power which feared an early end to their generous subsidies should the right-of-centre CDU be returned in a general election.

9. THE POLITICAL RISKS OF DOING NOTHING

The ongoing political inertia in the field of energy and climate change itself brings political risks, of at least two kinds. First, if a crisis should occur and the incumbent politicians were perceived to have failed to take action to prevent it – even if such action would have been opposed at the time by many people because they felt comfortable and did not want strong political leaders shaking things up – this could bounce back directly on the electoral prospects of those politicians themselves. The California power crisis was an example – the serious outages in 2000 and 2001, coupled with the vast costs incurred in the aftermath, were undoubtedly significant factors in Governor Gray Davis being replaced by Arnold Schwarzenegger in 2003. While a new programme of nuclear reactors could not make a significant contribution to secure supplies or reducing greenhouse gas emissions for some years, at least instigating such a programme would allow the politicians of the day to demonstrate an awareness of challenges to come.

The second risk is to the place of leading politicians in the history books. Politics is a profession that lends itself to such obsessions, both in terms of the type of characters it attracts and because real short-term improvements are often difficult to effect or demonstrate. While such considerations never entirely displace the essential short-termism of the electoral cycle in the minds of politicians, they add an extra element to it and reinforce the genuine desire of political leaders to make life better for people in the further future as well as the nearer – leading politicians can look to the long term and often do so.

In the past politicians have been particularly keen to be associated with exciting, large-scale technological developments which may have very long lifetimes indeed – air travel, the Channel Tunnel, nuclear energy etc. – all of which required considerable government support of one kind or another to get started and whose main implications have only been seen long after the terms of office of their early political supporters.

Examples of this can be still found today. The French government in particular has shown great enthusiasm for the next stage of nuclear fusion research (ITER, the International Thermonuclear Experimental Reactor), despite its high costs (total estimated at over €10 billion) and long timescale (fusion is unlikely to be available as a major energy source within the next forty years at least). By hosting the project France will reap considerable local economic benefits, but the widespread public support seems to be based on more than this, including elements of genuine excitement over the technology and a feeling that France should be at the forefront of technological development. (This being said, French environmental groups, notably Mediane, have opposed the project, quoting 2002 Nobel Prizewinner Matatoshi Koshiba who claimed that ITER did not meet 'a certain number of conditions, namely safety and economic costs'.[52]) It seems, though, that the decline of the importance of heavy manufacturing industry to many developed economies has reduced the allure of such projects for many politicians.

There is also a growing recognition that the main environmental threat of our time, climate change, is something with implications long beyond the terms of office, or even the lifetimes, of today's political establishment. This is coupled with a growing schism within the 'Green' movement over recent years between those who continue to oppose nuclear energy and those who have come to accept, sometimes with great reluctance, that nuclear energy may be essential, if only as a temporary measure to mitigate climate change while more 'sustainable' energy sources are developed. For example, Peter Harper and Paul Allen of the Centre for Alternative Technology in Machynlleth, Wales, pointed out that the worst possible nuclear disasters were not as bad as the worst possible climate change disasters and suggested 'a modest revival of nuclear energy at sites where there are already nuclear installations ... to sell the idea to the sceptics'.[53] As early as 2001 US commentators were reflecting on the apparent conversion to the nuclear cause among prominent American environmentalists as John Kerry (Democratic presidential candidate in 2004) and President Clinton's environmental adviser, Jerry Mahlman.[54]

There may be tentative reasons to think, then, that following the extraordinarily benign energy scene through the 1990s, which did not call for apparent large-scale intervention in the working of a short-term marketplace in many developed countries, growing numbers of politicians are now beginning to perceive the risks of a continued *laissez-faire* approach. They are therefore beginning to talk up the prospects of governmental intervention to promote longer-term measures to address the impending crises of energy shortages and climate change.

[52] http://www.dw-world.de/dw/article/0,1564,1631650,00.html, *DW-World.de*, 'France wins nuclear fusion plant', (18 June 2005).
[53] P. Harper and P. Allen, 'New Ethical Perspectives in Energy Policy' (unpublished, 2004).
[54] http://www.sepp.org/weekwas/2001/sept29.htm , M. Morano, *Greens Going Nuclear*, Science and Environmental Policy Project, 2001.

The challenge remains, however. How can politicians be persuaded – or, if already persuaded, how can they find ways – to act decisively before the crises take grip, given that it will be 'too late' by then? Growing recognition of the short-term and long-term political risks of ducking the issues in question may go some way to answering this question, as will promoting proper public understanding of the scale of what is involved for the future.

10. CONCLUSIONS AND RECOMMENDATIONS

The appropriate use of scientific research will improve the quality of decision-making within areas involving an interface between technology and society. This is not to say that science will always deliver the 'right' answer – scientific knowledge is only ever provisional – nor that scientists should be given *carte blanche* in making the final decision, as elected politicians (and the legal system) rightly bring wider social issues to the table, not least by offering appropriate protection of the rights of individuals. One can envisage an iterative process whereby society, through the political process (supported by research in social science), oversees scientific developments and communicates society's requirements, while the scientific/technical community creates innovative processes and 'reports back' to the political establishment as to what is technically and economically feasible.[55]

However, this is not what has been seen in recent years in most (though not all) developed countries. As society has become more comfortable, so the rights of individuals have moved centre-stage, coupled with a growing obsession with risks that are at worst very small and at best undetectable.

Politicians, partly because there is widespread misunderstanding of what science does and does not offer to the debate, have increasingly moved to downgrade the role of technical expertise – not just within the commercial companies involved in a particular activity but also in the academic community – by setting up panels and commissions in which voices representing (or claiming to represent) particular stakeholder interests or even affected individuals are accorded equal status to those with specialist knowledge. The 'precautionary principle', interpreted by opponents to a particular technology as a block to development until it can be proved that there is no problem – something which is logically impossible – has added to the difficulties in making sound decisions which will deliver the greatest benefit to people now and in the future.[56]

In these circumstances science cannot fulfil its full potential to contribute to effective decision-making. Furthermore, the 'lay committee' approach and the increasing emphasis on the views of individual victims or alleged victims of a technology is also serving to exacerbate fears (if government is spending a large amount of money looking

[55] http://www.psi.org.uk/docs/2003/esrc-energy-grimston-nuclear.doc, M. Grimston , 'Nuclear power', in *Proceeds of PSI/ESRC conference, Projects and policies for step changes in the energy system – developing an agenda for social science research*, 31 March 2003.

[56] Some commentators from within the scientific/industrial community have argued that, despite its theoretical shortcomings, the precautionary principle can be a valuable practical tool in designing regimes to manage emerging scientific techniques in ways that minimise potential downsides. See http://www.iddri.org/iddri/telecharge/mardis/s11_henry.pdf, C. Henry and M. Henry , *L'essence du principe de précaution: la science incertaine mais néanmoins fiable* (*The nature of the precautionary principle – dubious science but nonetheless reliable*), Iddri Seminar no. 11, Paris, 2004.

into an issue there must be a reason), to undermine the credibility of government when it claims that there is no significant problem (so why the research?) and to offer an excuse to politicians to procrastinate when urgent action is required now to head off a problem which may not emerge fully for some decades but for which the solutions cannot be introduced overnight.

Politicians perhaps deserve some sympathy – when society is feeling comfortable it is often difficult to raise awareness that things cannot go on as they are at present (e.g. the world getting 88 per cent of traded energy from limited reserves of coal, oil and gas, with major environmental implications). A comfortable society seems to reject 'strong' political leadership aimed at problems that do not seem to be urgent. Yet, as noted earlier, the timescales involved in investment in many industries, not least energy, can stretch to decades or even more. And when the serious problems re-emerge there will be plenty of people ready to criticize their political leaders for not having acted soon enough.

So politicians simply must be prepared to take difficult and (in the short term, at least) potentially unpopular decisions to safeguard long-term prosperity, the wellbeing of the environment, social stability and so on. The payoff may come after their term of office, though history may well be kind to their vision. Decisions need to be taken which will not exclude certain options for largely irrelevant reasons, e.g. the fear of constant and capricious changes in regulation which may drive investment out of heavily capital-intensive forms of electricity production even when these sources could play a valuable part in delivering the requirements of our energy systems.

In doing this science can be a strong ally, but only if politicians take the lead in reinstating technical expertise and research into the front line of the decision-making process. Society's obsession with very small risks should be challenged, not indulged and reinforced. The idea that difficult issues, such as the siting of a radioactive waste repository which may lead to conflicts between national and local priorities, can be consulted away as long as enough people are involved in enough committees is naïve and may be dissolving, if the experience of the Committee on Radioactive Waste Management (CoRWM) in the UK is any guide.

The technical community has its own part to play. It must be transparent in its dealings with government and also with academia – there must be no suspicion of scientists being leant on to hide or alter their findings if they cause short-term embarrassment or loss for the commercial company involved, but at the same time it is important that risks are not overestimated to satisfy some real or perceived political agenda. Popular media which understand the role of science and can report sensibly on issues of controversy is perhaps a wish too far.

Evidence suggests that in a small number of countries (notably in Scandinavia) the relationship between the political establishment and the people who elect it is mature enough to allow long-term decision-making with popular support, or at least acceptance. This often involves a programme of thoroughgoing consultation, coupled with rights of veto among local communities.

However, this does not mean that a similar approach would result in implementable decisions in countries with different political cultures and histories. In some such countries the choice (in practice) seems to lie between:

- a strong political stance which can deliver projects of national importance even in the face of regional opposition (though interestingly the communities which are closest to nuclear installations tend to be the most supportive of proposals for replacement plants or expansion); or
- interminable delay as the locus of decision-making (or rather its avoidance) moves further away from elected politicians and their civil servants and is dissipated among larger and larger numbers of 'stakeholders'.

Many of the topics which have been discussed in this paper, not least the future of energy, seem too important to be left floating in deliberative limbo.

APPENDIX 1: NATIONAL DIFFERENCES

Notwithstanding the historical narrative offered above, significant differences seem to prevail among different countries, depending on political culture or perhaps even 'national character'. For example, France and perhaps Japan appear to be countries where major issues of national importance such as siting decisions for waste repositories can be characterized by a utilitarian (technical-hierarchical) approach, it being assumed in the national culture that such matters will be dealt with by the state. By contrast, in Sweden and Finland public participation elements and the rights of individuals and local communities to influence their own future are more prevalent.[57] The Anglo-Saxons seem to lie somewhere between these extremes, more market-oriented but with governments which seem confused as to whether markets and consultation (on the one hand) or central diktat (on the other) are the appropriate mechanism for managing the interface between science and society. The present US government, perhaps ironically in the 'land of the free', appears to be taking an absolutist position on the decision to site waste at Yucca Mountain, pushing the project through despite strong local objection. Comments such as the following (made in the context of the development of underground railways in London and Paris) are common.[58]

> The French system of central planning was not the British way, which was dominated by its emphasis on entrepreneurship and a disdain for government involvement.

Such national differences have tended to thwart any attempts to harmonize waste management policy globally or regionally. For example, the European Commission published a 'nuclear package' in 2003 which included a draft Directive on the management of the spent nuclear fuel and radioactive waste. The proposal would have required Member States to accept deep geological disposal and to agree a definite timetable for implementation. However, the package was rejected by the Council of Ministers and the part relating to a timetable for nuclear waste was abandoned.[59]

A few examples of the way different countries have approached decision-making in the nuclear field may be illustrative, as long as we bear in mind the inevitable limitations of drawing firm conclusions from such complex and ersatz sources as national energy policies. These examples will focus largely on radioactive waste management, since, unlike new build at present, this is an issue for all nations which have used nuclear energy.

There are some key differences between decision-making in this field and that of new build, most notably in that some policy of waste management will be needed to deal with wastes which have arisen until now while there is no corresponding 'need' for new build. Nonetheless the decision-making processes and the influence of political support needed for progress to be made are likely to be similar. To take Finland as an example, although the votes in Parliament in favour of developing a waste disposal facility at

[57] See M. Hissemöller and C.J. Midden, 'Technological Risk, Policy Theories and Public Perception in Connection with the Siting of Hazardous Facilities', in C. Vlek and G. Cvetkovich (eds), *Social Decision Methodology for Technological Projects,* Kluwer Academic Publishers, Dordrecht, Netherlands, 1989.
[58] C. Wolmar, *The Subterranean Railway*, Atlantic Books, London, 2004.
[59] http://europa.eu.int/comm/energy/nuclear/safety/doc/com_2004_0526_en.pdf, Commission of the European Communities, *Amended proposal for a Council Directive (Euratom) on the safe management of the spent nuclear fuel and radioactive waste*, COM (2004) 526 final, CEC, Brussels, 2004.

Olkiluoto and of developing the country's fifth reactor (at the same site) were very different – 159-3 and 107-92 respectively – the tradition of consensual politics and respect for Parliament in the country suggests that both of these decisions will be implemented.

Perhaps five different types of society can be identified through such an exercise:

Type of society	*Examples*	*Prevailing ethic*	*Decision-making*	*Public attitudes towards science and technology*	*Role of Green movement*
'Fragmented'	Germany, Switzerland, UK.	Individualist	Muddled.	Mildly antipathetic.	Important and antipathetic to industry.
'Statist'	France, Japan.	Utilitarian	General acceptance of centralised political decisions.	Supportive.	Limited.
'Consensual'	Finland, Sweden.	Combined	Stepwise, inclusive.	Generally supportive as long as serves the public good.	Important but supportive of appropriate technology.
'Centralist'	USA.	Utilitarian	'Heads down' (Bush), but often muddled in recent past.	Ambivalent.	Fairly important and antipathetic to industry.
'Developing'	China, India.	Utilitarian	States take decisions but with relatively little opposition.	Strongly supportive.	Very limited.

It should be stressed that what might prove to be a successful mode of decision-making in one type of country – e.g. the step-wise approach, backed by considerable local powers of veto, which is prevalent in Scandinavia – might be anathema in another type of country, e.g. France, where the state is expected to take more decisions on behalf of citizens. The practical lessons to be learned, then, about successful decision-making in another country may be limited.

Finland and Sweden

The Scandinavian model of decision-making is characterized by a relatively consensual approach to cross-party politics and considerable public trust in government and

regulators,[60] further coloured by the position in which Finland in particular found itself during the years following the end of the Cold War. Indeed, Finland is a particularly interesting case, being the only West European country both to have identified a site for long-term disposal of highly active radioactive waste and to be in the process of building a new nuclear power station. However, as the figures cited above show, the degree of political unanimity around waste management policy contrasts with the controversial nature of the decision to allow construction of Olkiluoto-3 (which resulted in the Greens resigning from the governing coalition).

The decision-making process in both countries has been characterized by its step-wise nature (with the inherent possibility of stepping back if necessary). As long ago as 1983 the Finnish government set guidelines for the long-term policy of radioactive waste management. The 1987 Nuclear Energy Act introduced the concept of 'Decision-in-Principle' (DiP) into the process:[61] whenever such a decision is taken it allows for further work to be carried out but also leaves the process subject to further licensing steps depending on the outcome of that work. The DiP approach therefore requires early acceptance from a potential host community before any major investment in the project is made. Crucially, as a balance the new law also brought in an absolute right of local veto in the siting process. By 1987 the screening process for site investigation had reduced the number of potential host sites from 134 to five, two of which were eliminated in 1993.

Early in the process the concept of the 'best possible site' in geological terms was abandoned, as it was recognized that social and ethical factors, and especially the wishes of the local communities involved, should also be taken into account. Although there were protest movements in most of the areas under review, many people seemed to take the neutral position that if their home municipality were to be regarded as a suitable site they would accept the decision.[62]

A 1994 amendment to the Nuclear Energy Act made import and export of nuclear waste into and out of Finland illegal. Once it was established that Finland's waste would need to be managed within the country's own borders, there was a growing sense within the communities most associated with nuclear power production (Olkiluoto and Loviisa) of responsibility for waste management, and both communities offered themselves for final consideration as hosts for a deep geological repository. The Green Party voted in favour of the DiP for a repository at Olkiluoto in 2001, 'on the consideration that it felt it had an obligation to find a national solution to the problem'.[63] In 2000 a local vote in Eurajoki came out heavily in favour of a DiP to develop a repository at Olkiluoto (having rejected such a proposal some years earlier), followed by similar support from the government and, the following year, in Parliament (by 159 votes to 3). Construction of an underground laboratory began in mid-2004, with a view to seeking permits to begin constructing the repository in 2010 and to operate it in 2020.

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[60] See for example http://www.nea.fr/html/rwm/reports/2004/nea4429-stepwise.pdf, C. Pescatore and A. Vári, *Stepwise approach to decision making for long-term radioactive waste management – experience, issues and guiding principles*, NEA, Paris, 2004.

[61] http://www.stuk.fi/saannosto/19870990e.html, Finland Government, *Nuclear Energy Act,* 1987.

[62] J. Vira, *Step-wise decision-making in trial: the case of Finland.* Paper presented at the 9th International High-level Radioactive Waste Management Conference, Las Vegas, Nevada, 29 April–3 May 2001.

[63] http://www.nea.fr/html/rwm/docs/2002/rwm-fsc2002-1.pdf, J. Andersson, Session 4, NEA RWMC (2002), *Stakeholder involvement and confidence in the process of decision-making for the disposal of spent nuclear fuel in Finland*, 15–16 November 2001, Turku, Finland.

Most participants felt that the consultation process was carried out well, a major factor in the strengthening of trust among stakeholders (although this was less true in the case of some local protestors, who felt that the mandatory Environmental Impact Assessment had been unduly influenced by waste management company Posiva Oy[64]).

SKB, the company responsible for waste management, was established in 1973 by the nuclear utilities. Between 1977 and 1985 preliminary studies were carried out on ten sites and in 1992 SKB invited municipalities to volunteer for more detailed feasibility studies – eight did so. Some subsequently dropped out and SKB respected their decision, an important factor in building trust with the remaining municipalities.[65] (Like Finland, Sweden has abandoned the reprocessing of spent fuel, which it used to carry out through contracts with COGEMA of France until the mid-1980s.) In 2002 detailed studies began in two sites – Forsmark in Östhammar and Simpevarp in Oskarshamn – both of which had operating nuclear reactors. The supporting technical programme included the construction of two facilities in Oskarshamn, a Hard Rock Laboratory, commissioned in 1995, and a prototype repository (2003).

Strictly speaking, although municipalities in Sweden have considerable veto rights concerning their own affairs these may in certain circumstances be overridden by the federal government when it comes to the siting of a disposal facility. However, SKB stated that it intends to seek consensus and not go against the wishes of any municipality. A further factor that seems to have been important in building trust has been a clear division of roles, in which the nuclear power utilities are responsible for the management of the waste while SKB, though jointly owned by the nuclear power utilities, plans and executes work based on requirements defined by politicians, scientists and local residents.[66]

Although there has been considerable political debate and disagreement about the use of nuclear electricity among political parties in both Finland and Sweden (though with different results), this disagreement has largely not extended to debates about waste. As a result local politicians in Östhammar and Oskarshamn seem not to have felt strong pressure to reject feasibility studies. SKB has accepted that the benefit of meeting greater demands from the public and politicians for information to allow them to engage meaningfully in the siting process outweighs the disadvantages in terms of time and cost that greater efforts towards transparency inevitably bring (e.g. through opening local offices, greater provision of information etc.).

The following factors, then, may be regarded as being key political and social contributors to the success of the waste management programme in Finland and Sweden:

- a realistic timescale;
- a step-wise approach, with the possibility of stepping back if necessary;
- clear legislative requirements;
- veto power of local communities;

[64] http://www.nea.fr/html/rwm/docs/2002/rwm-fsc2002-1.pdf, K. Tuikka, Session 2, NEA RWMC (2002).
[65] http://www.skb.se/upload/publications/pdf/The%20management.pdf, R. Lidskog and A.-C. Andersson, *The Management of Radioactive Waste: A Description of Ten Countries*, SKB, Stockholm, 2002.
[66] SKB, *A Mission in Time*, SKB, Stockholm, 2003.

- fairness and transparency in the decision-making process;
- the decision to ban import and export of waste;
- independent review by the regulator;
- a clear and largely united cross-party steer from parliament.

United Kingdom, Germany and Switzerland

The UK, Germany and Switzerland can be regarded as examples of countries which fall between the thoroughgoing consensualism of the Scandinavians, where even controversial decisions such as that to build the fifth reactor in Finland have considerable credibility among those who oppose the final decision and are therefore likely to be implementable, and the more statist approaches taken (in different ways) by countries such as France, Japan and the USA, where the intention seems to be that centrally taken decisions should be carried through even in the face of vocal minority opposition. There is a degree of public consultation in these three countries but detractors claim that it always appears half-hearted and is limited to details of the final step, not to proper consideration of wider issues and how the proposals had been reached.

This being said, Switzerland takes many decisions by way of federal referendum while the importance of the regions (cantons or *Länder*) is rather greater in Switzerland and Germany than in the UK, leading to more difficult political and legal tensions between central and local government.

The UK was one of the first countries to deploy civil nuclear technology, yet the UK programme has on the whole been something of a disappointment, characterized by a series of prototypes, high construction costs and, at least in the case of the Advanced Gas-Cooled Reactors (AGRs), generally unsatisfactory output statistics. This, coupled with the discovery of large amounts of oil and gas in the North Sea, has served to undermine political support for nuclear energy. That the UK was also one of the first nuclear weapons states has undoubtedly also been a factor, although civil and military nuclear activities were formally separated at an early stage. By the mid-1990s nuclear new build seemed almost friendless within government, although this may be changing.

In 1982 Nirex was created by the nuclear industry to propose long-term management solutions for intermediate-level waste; it was not proposed that heat-generating wastes (high level waste and spent fuel) should be disposed of for some decades. Nirex only became independent of the nuclear industry in 2005.[67]

The UK programme for intermediate-level waste (ILW) has been characterized by a series of false starts, in which a site is identified, an argument ensues with the local population and the scheme is abandoned, usually just before a general election is called[68] – the UK seems a prime example of the problems caused by the vast difference in the timescales between the political timetable (general elections every four or five years, often punctuated by local elections in between) and the lifetime of a waste repository (measurable in centuries or even millennia). From 1983 to 1985 Nirex examined two sites, at Elstow, Bedfordshire and Billingham, County Durham. Public

[67] http://www.nirex.co.uk/index/inews.htm , Nirex Press Release (4 April 2005), *'Watershed' as Nirex made independent.*

[68] http://www.ccg.leeds.ac.uk/mce/mce-nirx.htm , S. Carver, *Where to Dispose of Britain's Radioactive Waste?,* University of Leeds, 1996.

opposition to both sites was considerable, resulting in the owners, ICI, withdrawing consent for the latter. In 1985 the Billingham proposal was abandoned and three more sites were added to Elstow. Again significant protest movements developed and all four sites were withdrawn in May 1987, a fortnight before an election was called.

By 1989 the 'long' list of potential sites had been reduced to twelve, although these were only made public in 2005 after an application under the new Freedom of Information Act.[69] Sellafield, which produced 65 per cent of the waste to be disposed of, became the preferred option in 1991. In 1994 Nirex applied to the local planning authority for planning permission to build a Rock Characterization Facility (RCF). Permission was refused and, after a public inquiry in 1997, John Gummer, the Secretary of State for the Environment supported the decision. The announcement was made on the day that the 1997 general election was called.

The 1997 decision in effect stalled the UK waste management programme. Arguments deployed by opponents have included criticism of the scientific basis of Nirex's case (especially with respect to the geology at Sellafield, a typical example of the attempts by opponents of controversial technologies to divide the political and scientific communities against each other), as well as heavy political lobbying. The decision of successive governments not to publish the list of potential sites, nor the criteria by which the decision had been made, led to suspicion that Sellafield had been chosen simply because of the economic dependence of the area on the nuclear industry (and hence the expected level of public support) rather than on sound technical grounds. That Nirex was co-owned by the nuclear industry was also exploited to erode public confidence in the process.

In 2001 a much-delayed public consultation exercise was launched.[70] The subsequent government White Paper,[71] sought, *inter alia*, to 'underline the government's commitment to ensuring that management arrangements are open, transparent and command public confidence'. A new Committee on Radioactive Waste Management, drawn from a range of interests including the environmental movement, was created to consider all potential options for long-term waste management. Key decisions over the way forward were to be taken in 2006. The chequered history of CoRWM has been considered earlier.

Germany, in contrast to its neighbour France, has in recent years turned its back on nuclear energy, to the extent that in 2000 the Social Democrat/Green coalition government passed laws to phase nuclear stations out before (though not long before) the end of their economic lifetimes. Why the German government should take such a different political stance from that taken in France is a complex issue, elements of which may include:

- a different attitude towards the role of the federal government in decision-making, coupled with a heavily decentralized federal structure of government which makes decision-making on a 'national' scale more difficult;

[69] http://www.nirex.co.uk/index/iold_list.htm , Nirex Press Release (10 June 2005), *Nirex publishes historic site list.*

[70] http://www.defra.gov.uk/environment/consult/radwaste/default.htm , DEFRA (2001), *Managing Radioactive Waste Safely*.

[71] http://www.dti.gov.uk/nuclearcleanup/pdfs/whitepaper.pdf., DTI, *Managing the Nuclear Legacy – A Strategy for Action,* 2002.

- Germany's large coal reserves (especially brown coal, which remains economic) which act as a buffer against increases in global hydrocarbon prices;
- proximity to gas reserves from the former Soviet Union;
- the internal politics of the coalition government, under which decision-making on energy was largely controlled by the Green Party.

Ever since civil nuclear power came into use in the early 1960s, German policy has been that all types of radioactive waste should be disposed of in deep geological formations – Germany constructed Europe's first underground laboratory in 1965. The search for a suitable disposal site began in 1973, when 24 salt domes in the state of Niedersächsen (Lower Saxony) were considered against a number of criteria. (These criteria were not published until 1977, after the Gorleben location had been chosen; Gorleben was apparently not on the initial shortlist.)

Federal politicians had hoped that the prospect of employment opportunities would go down well in the area but a protest rally at Gorleben in 1977 (the first of a long series of such actions) attracted 100,000 participants. Major demonstrations attempting to block the transport of spent fuel from German power stations to Gorleben have required massive deployments of police and border troops, despite a considerable degree of support for the projects within the communities most closely affected. Although wastes have reached the store, doubts have been expressed about whether a full programme of waste return from reprocessing in France and the UK can be implemented.[72]

Following the election of a new SPD/Green coalition government in 1998, waste management policy was reviewed, as part of the 'consensus talks' to find an acceptable way of fulfilling the coalition's promise to phase out nuclear power.[73] The review included the following aspects:

- a new national waste management plan for the legacy of radioactive waste;
- a single repository in deep geological formations sufficient for disposal of all types of radioactive waste to be available by the year 2030;
- exploration at Gorleben to be suspended to allow for time to resolve doubts and for alternative sites in various host rocks to be considered;
- licensing procedures for the Konrad repository project (started in 1982 but not yet concluded) to be completed: after award of the licence construction not to begin immediately, to allow for objections to the project to be dealt with before the courts.

In Germany, then, as in the UK, the lack of openness in the decision-making process which led to the identification of Gorleben as the location for disposal of highly radioactive materials, including a failure to make public the criteria used in selecting the site (and the apparent lack of fit between Gorleben and the criteria when they were eventually published) seems to have been a major factor in causing public disquiet and protest. Recognizing this, subsequent attempts have been made to involve the public at

[72] http://www.n-base.org.uk/public/report_links/gov_waste.html, A. Blowers , *Prospects for Nuclear Waste Clean Up: Is Consensus Achievable?,* 2002.
[73] http://wwwsoc.nii.ac.jp/aesj/publication/JNST2004/No.3/41_393-398.pdf, I. Beckmerhagen, H.-P. Berg and P. Brennecke, 'Recent waste management related developments in Germany', *Journal of Nuclear Science and Technology* **41**(3) (March 2004).

an earlier stage in decision-making. In the new framework for site selection criteria and procedures developed by the government elected in 1998, public opinion is given a central role.

- The site selection procedure will have a clear and transparent structure and will be based upon well-founded criteria to ensure that progress, fairness and objectivity of the procedure can easily be followed and that decisions are understood by the general public.
- The evaluation basis and criteria associated with the selection procedure will be fixed beforehand, to avoid decisions the public might perceive as not sufficiently justified or even arbitrary.
- Public participation will be viewed as indispensable in all phases of the selection procedure. This will include the definition of the criteria and the site selection procedure itself, the 'rules of the game'.

Once again, it seems that technical expertise is being replaced by influence from pressure groups, with no clear sign that political leadership will be exercised to ensure a final resolution of the issue.

Switzerland is a federal country in which considerable political power resides with the cantons. Binding referenda play a more important part in the political process in Switzerland than in many countries and therefore public attitudes tend to be translated more directly into laws. For example, in 1990 a ten-year moratorium on new nuclear plant construction was supported by 55 per cent of the electorate.

In 1993 NAGRA, the company established in 1972 by the federal government and the operators of Switzerland's nuclear power plants to manage all categories of radioactive waste, identified a site for low-and intermediate-level waste at Wellenberg in the canton of Nidwalden, following a process which began with 100 potential sites in 1978. However, a cantonal referendum in 1995 rejected the granting of a licence for the repository by 52 per cent to 48 per cent and the plan was shelved. The following factors were identified as contributing to the result:

- the process moved too quickly, allowing neither population nor politicians sufficient time to gain appropriate knowledge on the issue;
- there was a strong campaign of opposition from environmental groups and the media, supporting a step-wise approach which would allow for retrieving the waste rather than sealing the repository once it was full;
- the license application included both exploratory work and actual construction of the repository – had it been restricted to exploratory works alone polls suggested that a significant majority would have voted in favour.

After the 1995 referendum several working groups were set up to look at technical, economic and consultative issues and a number of relevant societal and ethical issues were identified,[74] including the need to create an adequate societal decision-making process for repository implementation. At the same time a new set of measures was implemented, including a stepwise approach towards implementation and the provision

[74] P. Hufschmied et al., *'Monitored long-term geological disposal', a new approach to the disposal of radioactive waste in Switzerland,* ENC 2002 Scientific Seminars, Lille, France, 7–9 October 2002.

of a sufficiently long period of reflection to allow the public to take a decision on final closure based on solid knowledge.

The political and social principles underlying Swiss radioactive waste management policy were expanded in a report of the Expert Group on Disposal Concepts for Radioactive Waste (EKRA),[75] which had been created in 1999. The relevant section of the report opens by stating:

> Further developments of the Swiss concept [regarding radioactive waste management] have to take social expectations into consideration. Up till now too little attention has been paid to these expectations.

However, despite the post-1995 efforts, a proposal for underground investigatory work to be carried out at Wellenberg was rejected again in cantonal referendum in September 2002 and the site was subsequently abandoned as an option. In the process several voters seem to have formed the impression that the authorities had decided on this site and were 'consulting' merely to improve their chances of getting their way. EKRA's report after the 2002 referendum[76] made a number of recommendations:

- competence in the field of waste management should be exclusively at the federal level, though importance should be attached to regional participation rights;
- the federal government should specify binding timescales for the commencement of operation of deep geological storage facilities;
- a waste management council should be established and an independent, interdisciplinary research programme should be initiated;
- licensing and safety authorities should be separated from one another.

The setback, then, galvanized the federal government back towards a willingness to take central decisions, although a degree of ambiguity remained concerning the extent to which decisions should be taken centrally or dictated by the outcome of local consultation. Most notably, although comprehensive participation rights apply to cantons and their immediate neighbours and to neighbouring countries, the 2004 Nuclear Energy Act removed the local cantonal veto in the waste repository siting process. Swiss politicians have therefore moved in the opposite direction from those in Scandinavia, who have been giving greater powers of veto to local communities as part of the process of building genuine trust. The basic political decision to construct a repository will now be a general licence issued by the Federal Council.

In May 2003 Swiss voters rejected two anti-nuclear proposals originally put forward in 1998. 'Electricity without nuclear' called for the overt phase-out of nuclear power by 2014 while 'Moratorium plus' would have removed incentives to invest in and upgrade nuclear plants (and might therefore have led to a very similar outcome). Two-thirds of voters rejected the first proposal and 58 per cent rejected the second.

[75] http://wwwt.bfe.admin.ch/imperia/md/content/informationenlinks/broschren/2.pdf, W. Wildi et al., *Disposal concepts for radioactive waste: final report, Expert Group on Disposal Concepts for Radioactive Wastes*, Bern, Switzerland: Federal Office of Energy, 2002.
[76] Ibid.

In summary, then, despite their obvious differences these countries share a lack of progress in resolving radioactive waste management policy. One can speculate that what they have in common is an ambiguity in the decision-making philosophy – in each case local communities have been given the impression that they will have a serious input to the final decision but the criteria on which such proposals have been formulated are kept from them. The impression that consultation is mere 'window dressing' seems to destroy trust, and therefore damage the implementability of a decision, more effectively not only than sincere consultation but also than no consultation at all. The 'strong leader' who sets a direction and sticks to it seems to command more respect, perhaps even at times of societal comfort, than those who pretend to seek local views but continue to push their own agenda.

Prior to 1997, for example, the UK sought to follow a decision-making process which was marked by limited public participation and a lack of transparency about the criteria being used for site selection. It ultimately became clear that this approach was politically impossible to implement. Germany and Switzerland faced similar problems for similar reasons.

The initial response in each case was to try to consult the problem away, by creating structures which embedded the opposition of various groups into the decision-making, or at least the advisory, process, at the expense of technical expertise. This reintroduces one of the main themes in the relationships between the political establishment and long-term scientific/technical issues such as nuclear energy.

In a project as long-term as a radioactive waste repository, or even a nuclear power station, there will be a degree of political pain in the short term which will fall on head of the government (or individual minister) who has taken the initial decision. Even if the decision can be portrayed accurately as being for the 'national good', the benefit in question will not crystallise for some years or even decades – after (probably well after) the term of office of the politician or politicians who must act now. 'NIMTO' (Not In My Term of Office) has come to rival NIMBY ('Not In My Back Yard').

The degree to which NIMTO seems to influence decision-making differs considerably among nations. In countries such as Switzerland, Germany and the UK the legacy of mistrust which has built up (and which, some would argue, the nuclear industry and its regulators helped to create) will be difficult to overcome. It cannot be assumed, therefore, that the approach taken by, say, the Scandinavians over many years would 'work' in those countries with a poorer track record of genuine public involvement in decision-making. The decision of residents of Nidwalden canton to reject on two occasions a repository at Wellenberg – incidentally despite a considerable degree of support among residents most closely affected – has led Switzerland, in direct contrast to most other countries, to take steps to reduce the powers of local authorities to reject federal plans, by removing the cantonal right of veto. Whether this is a 'good' thing or not is of course hotly debatable, but it may well be the first recognition that half-hearted public involvement is worse than none and that, to implement necessary decisions, politicians have to be prepared to take a stand. Creating committees which degrade the position of technical expertise in an attempt to win public legitimacy is unlikely to succeed.

USA

The process being followed by the federal government of the USA in implementing its nuclear waste management policy, by contrast, seems to be one underpinned by thoroughgoing utilitarianism coupled with a centralized approach to decision-making.

The USA has the world's largest nuclear industry, including over 100 operating nuclear reactors, as well as having developed the world's first nuclear weapons programme. Yet no reactor ordered since 1974 has been completed. A combination of public opposition following the Three Mile Island accident in 1979 and disappointing project management (many plants suffering major time and cost over-runs, in part because of changes in regulation post-TMI) served to undermine confidence in nuclear power, and liberalization of electricity markets in a number of states using nuclear energy further reduced incentives to invest in new build.

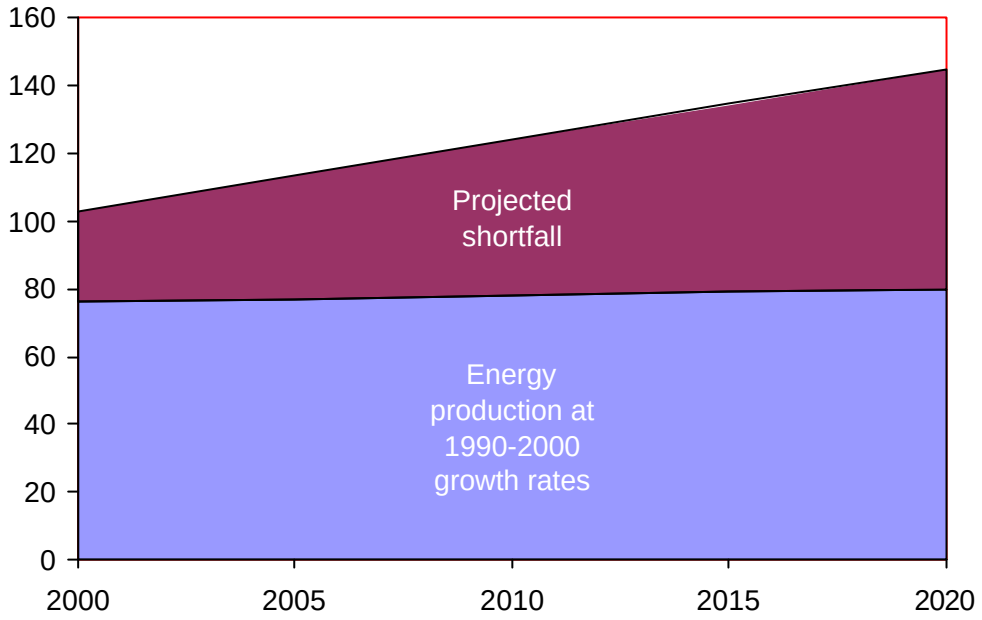
There is evidence of a change of heart, however. In 2001, Vice President Dick Cheney said of nuclear energy, 'If we're serious about environmental protection, then we must seriously question the wisdom of backing away from what is, as a matter of record, a safe, clean, and very plentiful energy source'. In 2005 President Bush called for more nuclear power and the Energy Bill, finally signed into law in August 2005 after four years of debate, included a number of measures to support investment in nuclear energy (and other energy sources, notably renewables).

This change, which also saw renewed support for renewables and for coal-fired technologies, was driven by growing perceptions of an 'energy gap' – in its proposals for establishing a National Energy Policy the National Energy Policy Development Group stated: 'A fundamental imbalance between supply and demand defines our nation's energy crisis'[77] – coupled with concerns about the stability of oil imports from the Middle East in the wake of the terrorist attacks of September 2001. Such events and circumstances seem to have served to create the sense of stress under which 'strong' leadership can flourish. Figure A1 shows the projected US energy consumption and production.

In addition, American politics for some decades has been dominated by a desire to maintain US hegemony on the world stage. Whenever this has seemed to be in question American presidents often take firm action which would seem paradoxical within a nation which has seen itself as the 'land of the free' and in which the role of the state has been correspondingly smaller than in many other developed nations. The USA's position as the world's only 'superpower' may be under threat if it becomes too dependent on potential enemies for its energy supplies. The terrorist threat also served to focus attention on the need to remove highly radioactive wastes from storage on or near the surface to a repository deep underground.

[77] http://www.whitehouse.gov/energy/National-Energy-Policy.pdf, National Energy Policy Development Group, *Reliable, affordable and environmentally sound energy for America's future,* 2001.

Figure A1: Projected US energy consumption and production (PJ)



In 1982 the Nuclear Waste Policy Act (NWPA) established a framework for siting, characterizing, constructing, operating, monitoring and closing a permanent geological repository for disposal of spent fuel and high-level wastes. The Act also established a Nuclear Waste Fund, financed by a 0.1¢ per kWh levy on electricity generated in nuclear power stations – by the end of 2000 the fund had received just over US$ 15 billion.

In 1983 nine sites were identified for further investigations, reduced to three in 1985 and one (Yucca Mountain, Nevada) in 1987. However, progress has been slow. An Exploratory Studies Facility (ESF) to obtain data about the suitability of the site was completed in 1997 but it was only in 2002 (prompted in part by the events of September 2001) that the Bush administration determined that it was technically and scientifically feasible to build a facility at Yucca Mountain. Congress subsequently approved the site despite a 'disapproval' from the State of Nevada.

The politics of waste disposal in the USA has not been severely affected by the fashion for widespread consultation. US law does provide for consultation over major projects such as Yucca Mountain – the Yucca Mountain communications staff has a formalized process for public participation in decision-making related to the site, developed to fulfil the requirements of the National Environmental Policy Act (1969), the Nuclear Waste Policy Amendments Act (1987) and the Executive Order 'Federal actions to address environmental justice in minority populations and low-income populations' (1994).[78] The Office of Civilian Radioactive Waste Management also produces newsletters, brochures and regular updates on the project. The USA has strong legal institutions and a high degree of devolution of power to the individual states, which often lead to considerable delays in implementing federal policy – the Nuclear Waste Policy Act allows 'Affected Units of Government', including Nevada State and the counties most affected, rights to

[78] http://www.epa.gov/history/topics/justice/02.htm .

an oversight over the repository. From 1983 to 1995 Nevada State received oversight funds, counties have been funded since 1989 and a vigorous campaign against the use of Yucca Mountain has been waged by Nevada state using a variety of technical, political and legal arguments.

Nonetheless, national politicians are prepared to pursue a command-and-control model of decision-making, at least so far as radioactive waste disposal is concerned. Local populations have no absolute right of veto to federal waste disposal proposals and the process of consultation has made little apparent material difference to these proposals, although actions by objectors have added considerable delays and costs to the project. The federal government has pursued a policy of imposing a repository at Yucca Mountain against the opposition of Nevada state, despite criticism from some quarters.

> They might have been more attentive to some of the key public concerns over the siting of a waste repository, especially to the issue of fairness and equity. That realization could have pointed them to another growing consensus that favours a more active, participatory role for affected publics and other key stakeholders in the process of making key decisions.[79]

The pressure to develop a site for a deep geological repository for highly radioactive materials gained new impetus after September 2001, when it became clear that surface facilities could be vulnerable to attacks of a kind not previously envisaged. The result of the 2004 presidential vote in Nevada showed only a small narrowing of President Bush's majority over his Democrat rival (and actually an increase in his percentage of the vote) despite his vocal advocacy of siting the waste repository in that state.

It is at least arguable that in the USA since 9/11 we have seen a society moving from a broadly deontological ethic to a utilitarian one, more characteristic of societies 'under stress'. One concomitant of this has been a reversal of the decline of deference towards traditional politics – despite the best efforts of satirists such as Michael Moore the 2004 election turnout was the highest since 1968 (rising from 54 per cent in 2000 to nearly 61 per cent) and saw growing support for President Bush, widely seen as a 'strong leader' by both supporters and detractors. The Bush regime appears to be prepared to act along 'decide-announce-defend' lines in pushing through its determination to dispose of waste at Yucca Mountain, despite the prospect of years of legal wrangling.

While this approach is in stark contrast to that being pursued in Scandinavia, it may ultimately prove just as successful, and more so than policies being followed in those countries which have made some gesture of serious public consultation without reaching the standards of openness and involvement characteristic of Finland and Sweden.

France and Japan

The politics of nuclear energy in France has been one of consistent support for many years. The elements of this seem to include a number of factors, e.g.

- limited reserves of fossil fuels, a problem which was thrown into high relief in the mid- to late 1970s when oil, responsible for 69 per cent of France's primary energy requirements in 1973, quadrupled in price;

[79] G. Rosa, cited in M. Llanos, 'Nuclear waste: no way out', *MSNBC News* (6 June 2002).

- a successful nuclear energy programme, especially in economic terms, based on a small number of related designs which were batch-built in significant numbers;
- the weaving of nuclear technology into the national political and social fabric – for example, rather less of the 'fear of the unknown' which affects the public and political profile of nuclear energy in other countries;
- a political culture which favours and expects decision-making on a national scale, coupled with a relatively centralized political structure in which relatively little power is delegated to the regions.

France is in the unusual position of pressing ahead with new build without having made significant progress towards identifying a waste management route – indeed, in the latter area the experience of France is not very different from that of a country such as the UK or Germany.

Andra, the entity responsible for the management of all radioactive wastes in France, was created in 1979 as part of the French Atomic Energy Commission (CEA). It was funded by the waste producers. In 1991 Andra was converted into an independent state-owned organization, reporting to the ministries of industry, environment and research. Initially France considered deep geological disposal as the appropriate solution for managing high-level long-lived wastes. However, protests against four test drilling sites in the late 1980s led to a moratorium in 1990. A parliamentary commission argued that it was premature to decide on deep disposal as the only approach and that a more democratic process should be developed involving elected representatives and local communities. A new motto was coined – 'responsibility, transparency and democracy'.

The subsequent Nuclear Waste Act (1991) required that research should be carried out on three approaches, that an overall assessment should be discussed in parliament in 2006, after which a final strategy was to be adopted. In an attempt to make the siting of research laboratories more acceptable, the law included provisions that waste could not be stored in such facilities – such guarantees aimed at smoothing the short-term politics of decision-making are quite common in a range of countries.

In 1993 thirty *départements* showed initial interest in hosting a waste research laboratory, only ten of which could meet geological criteria. In due course four *département* councils voted in favour of hosting a laboratory. The possibility of receiving financial compensation seems to have played a role in this – the council votes could in any case have been overruled by the national government (in contrast to the situation in Finland and Sweden, and also in Switzerland at that stage).

However, in 1997 the government decided to postpone a decision on the laboratories for a year owing to upcoming elections. In December 1998 one site (at the border of the Meuse and Haute-Marne *départements*) was chosen and a laboratory was constructed at Bure to investigate disposal in clay geologies. A search began to identify a second site where research into granite formations could be carried out.[80]

[80] http://www.laka.org/teksten/afval/2-discussions-00/, R.J. van den Berg and H. Damveld, *Discussions on nuclear waste – a survey on public participation, decision-making and discussions in eight countries: Belgium, Canada, France, Germany, Spain, Sweden, Switzerland, United Kingdom,* Laka Foundation, The Netherlands, 2000.

It is generally accepted that the 'decline of deference' in authority which has been seen in the democracies has not been as marked in France as in some other countries. One corollary is that public participation in decisions about matters such as the siting of radioactive waste facilities has tended to be relatively underdeveloped when compared with, say, the Scandinavian countries. In the 1990s there was criticism that the process involving the four *départements* being considered for underground laboratories was insufficiently transparent and was rushed, with local populations not consulted sufficiently as required by the 1991 law. When the subsequent process of public inquiries and council votes began there was considerable opposition: some 6,500 written objections were received in the Meuse *département*, for example. Protestors argued that since *département* councils had little power to reject proposals they tended not to listen to local concerns.

France also has a long tradition of compensating local communities for accepting schemes of national importance, involving for example the negotiation of 'volunteer incentives', where a package of local agreements was agreed with the three adjacent communities. Benefits might include development of local facilities, establishment of research institutes and payment of local tax rebates (known as 'professional taxes'). Such compensation, deeply embedded into the implementation of national policy in France, is sometimes decried as 'bribery' in other countries. It would seem important that compensation is not used to persuade people to behave unethically, say in accepting money in return for consenting to construction of a waste management facility that would not sufficiently protect future generations. There are also questions about who should be compensated and how, and what process should be used.[81]

This being said, the French institutional framework cannot be characterized in any very simple way. While there is certainly a 'Bonapartist' tradition, represented by the former President de Gaulle, for example, there are also other traditions which are far from authoritarian – '*l'esprit gaulois*'. As in other countries, the Chernobyl accident prompted more transparency (e.g. the creation of an independent and credible safety authority) and more 'participative democracy' (*Commissions Locales d'Information*). In recent years French governments have moved towards a more consultative position, at least in principle – the establishment of local liaison committees during discussions about establishing underground laboratories seemed to have a positive effect on local opinion and there was little local protest, for example, about the research laboratory at Bure.

In 1995 the CNDP (National Commission for Public Debates) was set up, with provision for each such debate to be organized by a special commission which would provide an overview of the topic.[82] In 2003 France instituted a major public debate covering energy policy, followed by three concerning nuclear energy specifically (on long-lived radioactive wastes, the next reactor and a proposed uranium enrichment plant, Georges Besse II).

During the energy debate the French media tended to imply that it was a sham but supporters of the process note that the public has become more aware of issues such as climate change and topics involving nuclear energy than was the case before. However, the debate on waste disposal, the main activities of which were planned to take place

[81] http://www.nirex.co.uk/foi/corwm/corwm4.pdf, K. Rawles , *Compensation in radioactive waste management: ethical issues in the treatment of host communities*, Nirex, Didcot, UK, 2002.
[82] http://www.debatpublic.fr, CNDP website.

between September 2005 and January 2006, seemed to be following a pattern familiar in the UK and elsewhere. Two 'deputies' wrote a report covering the main points, following which the government appointed a CPDP to organize the debate. However, in the view of the technical community the major characteristic of the process was that the president of the CPDP was determined to avoid criticisms of pro-nuclear bias, with a result that opponents to nuclear energy held a disproportionate number of places.

Japan is also a country in which deference to the government has continued at a higher level, at least until very recently. (The Liberal Democratic Party has held power continually since its formation in 1955, except for a brief period in the mid-1990s, despite periodic scandals and apparently endemic factionalism.) As in France, the case for nuclear energy has been particularly strong in Japan, which started nuclear generation in 1966 under the Atomic Energy Basic Law. Japan does not produce oil or gas and its coalmining production has shrunk to a mere one million tonnes a year, while the economy is one of the largest per capita in the world. Nearly 80 per cent of Japan's total energy supply is dependent on imports. In 1970 oil, imported mainly from the Middle East, supplied 77 per cent of total energy supply. As a result of the Middle East oil crises of 1973 and 1979/80 the programme of nuclear energy plants was expanded, new reactors being opened at the rate of two every three years. The share of nuclear energy in the primary energy mix grew from 2 per cent in 1973 to 13 per cent in 2004, while that of oil fell to 47 per cent. In 2004 54 nuclear stations supplied 274 TWh of electricity, representing 29.3 per cent of total power generated in the country and making Japan's the third biggest nuclear industry in the world. In July 2001, a ten-year energy plan calling for an increase in nuclear power generation by about 30 per cent (13 GW, i.e. between nine and twelve new nuclear plants) by 2011 was submitted to METI (the Japanese Ministry of Economy, Trade and Industry) and subsequently endorsed by the Cabinet. In March 2002 the Japanese government announced its intention to further expand nuclear energy in order to achieve greenhouse gas emission reduction goals set by the Kyoto Protocol.

Public support for nuclear energy in Japan was initially strong, both because of the perceived need for the technology and because Japan has traditionally had one of the strongest cultures of deference to government and senior officials in industry and academia. Local communities hosting a nuclear plant would receive suitable compensation.

However, public confidence in both the nuclear industry and the government and its regulators has been dented in recent years. Several incidents have contributed – a fire at the Monju prototype fast reactor in 1995, another at the JNC (Japan Nuclear Cycle Development Institute) waste facility at Tokaimura in 1997 and the criticality accident at a small fuel fabrication plant, also at Tokaimura, in 1999 which resulted in the death of two workers and some minor offsite contamination and which attracted international publicity.

A number of measures were taken to counter the decline in public confidence. In 1998 a Special Committee on High-Level Radioactive Waste Disposal, set up by the Atomic Energy Commission (AEC), recommended increased disclosure of information and greater openness and transparency in conducting research and development and in site selection procedures. 23 'Radioactive Waste Symposiums' were held in major Japanese cities between 1998 and 2000 while JNC held four forums on HLW disposal and provided space on their website for the public to comment.

Although the electricity generators responded to the 1999 accident by setting up the Nuclear Safety Network (NSnet), the main activities of which are to enhance the safety culture of the nuclear industry, conduct peer reviews and disseminate information about nuclear safety, concerns continued to grow. They were exacerbated by two scandals. In 1999 it was revealed that quality control checks on some mixed oxide pellets for use in Japanese reactors had been falsified by workers at BNFL's Sellafield plant in the UK. Then in 2002 questions emerged about possible falsification of documents concerning safety checks involving potential cracks in reactor shrouds at TEPCO's 17 reactors in Tokyo. By May 2003 TEPCO had shut down all of its reactors for inspection, only seven restarting before the end of the year. Replacement power cost on average over 50 per cent more than the ¥5.9/kWh (US¢5.3) nuclear generation cost.

Japan has tended to classify waste into two streams – high-level (HLW) and low-level (LLW).[83] The former includes spent fuel, vitrified highly active waste and long-lived intermediate-level waste. Japan has reprocessed its spent fuel in facilities in the UK and France (the last shipment of spent fuel was sent in 1998) pending completion of its own reprocessing facility at Rokkasho-mura, expected to come on line in 2007 after many years of delay. In addition to power station wastes, up to 50,000 canisters of HLW and long-lived ILW will have been produced by 2030 from over 10,000 tonnes of reprocessed spent fuel. Deep geological disposal has been the preferred option since an Atomic Energy Commission (AEC) statement in 1976. JNC's primary objective, exercised over three decades (including work carried out at the Tona Geoscience Centre at Tokaimura in Gifu Prefecture), has been to assess the technical reliability of the approach. For most of this period generic issues, especially those concerning Japanese geology, have taken precedence over site selection.

Major organizational changes have taken place in nuclear waste management in Japan in response to the decline in public confidence. As early as March 1996 the 'Long Term Nuclear Energy Policy Forum' was established with a view to allowing open and frank discussion by sceptics and nuclear opponents. Before 2000, waste management policy had been as follows:[84]

- disposal of VLLW, LLW and short-lived ILW in a near-surface operational facility being developed in stages at Rokkasho-mura in northern Japan (total capacity 600,000 m^3) – LLW disposal began in 1992;
- storage of spent fuel at existing nuclear sites or at off-site stores yet to be developed (construction of these were permitted under the new HLW law);
- storage of vitrified HLW and long-lived ILW from reprocessing of spent fuel in Europe at an existing facility, also at Rokkasho-mura, prior to disposal in a deep repository at a site yet to be identified.

In June 2000 the Law on Final Disposal of Specified Radioactive Waste (the 'Final Disposal Law') confirmed that vitrified high-level waste would be disposed of through deep geological disposal.[85] The Law also mandated the creation of a new organization,

[83] http://www.japannuclear.com/nuclearpower/program/waste.html, Federation of Electric Power Companies of Japan (FEPC), *Managing the Waste Stream from Nuclear Power,* 2002.
[84] http://www.defra.gov.uk/environment/consult/radwaste/pdf/radwaste.pdf, DEFRA, *Managing radioactive waste safely: proposals for developing a policy for managing solid radioactive waste in the UK*, 2001.
[85] Although the possibility of disposing of unreprocessed spent fuel in the same way has been discussed, the Japanese feel that spent fuel is likely to remain an important potential source of fresh fissile material,

the Nuclear Waste Management Organization of Japan (NUMO), with overall responsibility for HLW disposal. NUMO has responsibility not only for carrying out assessment studies for site selection and developing and demonstrating reliable disposal technologies, but also for reflecting opinions from local communities and obtaining confirmation from the government for the selected site. NUMO has begun an open consultation process to find a site and by 2007 intends to shortlist areas which are interested and potentially suitable. The more promising sites are to be subject to detailed investigation by 2012 and a third phase (to 2025) will end with site selection. The repository should be operational in about 2035 and the ¥3 trillion (US$ 28 billion) cost is to be met by a levy of 0.2 ¥/kWh from electricity utilities (paid to NUMO). This sum excludes any financial compensation paid by the government to local communities. Several underground studies in existing mines have already been carried out and two more underground research facilities are planned.

The site for the LLW repository, at Rokkasho-mura, was selected by the national authorities. Because of falling public confidence in the industry in the late 1990s a 'Nuclear Fuel Cycle Council' was established, which involves national and local government officials, including the governor of the prefecture in which the facility is situated. Among other things, this was intended to increase public involvement in safety monitoring at the site. A new liaison committee was established at the LLW disposal site to inform local people and officials about the development of the reprocessing plant there, as well as involving them in the monitoring of the vitrified HLW store. Agreements have been reached to pay similar compensation packages to communities around existing waste facilities as are currently paid to those around reactor sites and it is possible that the same will be offered to candidate sites.

In effect, then, Japan's government responded to a growing sense of mistrust among the population by instituting a variety of methods for 'public consultation' and by introducing considerable delays in the process for disposing of radioactive waste, in a way reminiscent of several Western countries.

The implications of this loss of public confidence on other aspects of nuclear activity have been considerable. As early as August 1996, when Japan's first referendum was held in Maki town, Niigata Prefecture, to decide whether or not to accept a nuclear power plant, 68 per cent of residents objected to the proposal. The Mayor also rejected the special subsidies from the central government for nuclear power development. In 2003 Chubu Electric Power Company abandoned plans to construct two 1,300 MW reactors at Ashihama in Mie Prefecture after its governor, Masayasu Kitagawa, ordered the cancellation of the project.

In a 2001 referendum residents of the village of Kariwa, also in Niigata, voted to refuse TEPCO permission to use mixed oxide (MOx) fuel in the local 8,200 MW Kashiwazaki-Kariwa plant.[86] Takamitsu Sawa, Director at Kyoto University's Institute of Economic Research, said, 'I personally think this vote is very significant ... and that the government will be forced to make a major revision in Japan's nuclear policy'. However, senior government and industry officials were quick to repeat their commitment to the use of

notably plutonium and unused uranium, so retrievability of spent fuel is a more important issue than it is with HLW.

[86] http://www.commondreams.org/headlines01/0528-01.htm , Miho Yoshikawa, 'Japan's nuclear industry in shock after "no!" vote', *Common Dreams News Centre* (28 May 2001).

MOx, adding that they would work harder to gain the public's understanding of nuclear issues, implying that Japan's commitment to public involvement and consultation may not stretch to a willingness to change policy in response. (The Kariwa referendum is not binding on the company.) Similarly, NUMO, discussing site selection, has stated that:

> In the siting process, it is especially important to promote public understanding of geological disposal and to obtain their trust. It should be noticed from this point of view that site selection will proceed in a stepwise and transparent manner as clearly defined in the Act. In order to ensure this, NUMO is taking a variety of measures to enhance confidence in its activities, for example, the publication of documents, a website, etc., and provides opportunities for concerned people to voice their opinion.[87]

This implies perhaps a one-way model of communication whereby people are to be persuaded of the correctness of the approach being taken by the 'establishment' rather than a genuine dialogue. In this the Japanese may resemble more those countries which are seen to be playing lip service to public involvement, rather than following a policy either of thoroughgoing public involvement or of determined central policy-making. This being said, the initial consultation on a site for HLW disposal has been carried out on a volunteer basis, with financial support offered to 'encourage' such volunteers. NUMO has concluded that the first quarter-century of waste management has taught:

- stakeholder confidence is the basis for public trust, dialogue being desirable to identify stakeholder concerns and to increase public trust in the disposal concept in accordance with the site selection process;
- a robust safety concept, based on a combination of an appropriate geological environment, an effective engineered system and a reliable safety assessment, is essential but may not always be enough, by itself, to justify stakeholder confidence;
- an independent, technically competent regulator, working as a bridge between stakeholders and the repository implementing organization, may help to gain increased public trust in a fair, equitable and safe process.

[87] http://www.wmsym.org/Abstracts/2002/Proceedings/1/570.pdf; S. Masuda , 'A quarter century of nuclear waste management in Japan', *WM '02 Conference*, Tucson Arizona (24–28 February 2002).

APPENDIX 2: EXAMPLES OF CONTROVERSIAL SCIENTIFIC/POLITICAL ISSUES

BSE

In the mid-1990s in the UK high levels of public concern developed concerning the possibility that Bovine Spongiform Encephalopathy (BSE or 'mad cow disease') might cross the species barrier into humans in the form of 'variant Creutzfeld-Jakob disease' (vCJD), a fatal condition which involves rapid deterioration of the central nervous system.

Interestingly, the public panic over BSE happened after the issue had largely been 'solved'. Actions (e.g. a ban on cattle protein in cattle feed) had been taken from the late 1980s to prevent the spread of BSE through cattle herds and the number of BSE cases had fallen from 36,861 among cattle born in 1987 to 3 among cattle born in 1996.[88]

Nonetheless, after a long period in which politicians had asked the question 'can BSE be transmitted to humans through infected beef?', scientists had answered 'not so far as we can tell' and politicians had heard 'no', some evidence began to emerge that the disease could indeed cross species. The evidence was (and is) highly equivocal – despite predictions that there might be some 500,000 cases per year, for example, the total number of cases of vCJD so far has been little over 100, some of which do not seem to be associated with eating beef. Indeed, some commentators argue that, far from there being some kind of 'cover-up' over the dangers of beef – a universal claim in all such issues – 'evidence that was awkward or contrary [to the belief that BSE and vCJD were linked] was either played down or just outright ignored. It is almost like they made their minds up about a link between BSE and vCJD and so they set about confirming it'.[89]

However, prominent experts in neuropathology and physiology such as Professor Colin Blakemore and Sir Bernard Tomlinson announced that they had stopped eating beef and Health Secretary Stephen Dorrell (in contrast to the stance taken by former Agriculture Secretary John Gummer, who famously fed a beef burger to his daughter in public in 1990) announced a possible link between BSE and vCJD to Parliament in March 1996. British beef was banned from many important overseas markets while on-the-bone cuts like T-bone were barred at home.

The government's response to the BSE crisis set a pattern which has become established with respect to such issues – one which, it can be argued, is driven by the misconception that science can ever prove a negative. A report is commissioned from a prominent person – in the case of BSE this was Master of the Rolls Lord Phillips[90] – in the hope that it will allay public fears about the matter in question. However, given the nature of such issues – often characterized by new phenomena involving very small numbers of individuals in circumstances in which it is difficult to carry out properly controlled surveys or experiments – the statements of reputable scientists can only be equivocal. (This is especially the case where there is reason to believe that there may be a considerable gap, or 'latency period', between exposure to the alleged risk and the

[88] http://www.fao.org/ag/AGA/AGAP/FRG/Feedsafety/PDFs/bsebull.pdf, MAFF, *BSE Enforcement Bulletin 52*, 2000.
[89] http://bmj.bmjjournals.com/cgi/content/full/323/7317/858, G. Venters, 'New variant Creutzfeld-Jakob disease: the epidemic that never was', *British Medical Journal* **323** (8), 13 October 2001.
[90] http://www.bseinquiry.gov.uk/report/index.htm , BSE Inquiry, *The Report*, 2000.

development of any symptoms, as was the case in BSE/vCJD. In such circumstances scientists are bound to say that the longer-term risks are by their very nature extremely difficult to assess.)

Thus, however tentative the positive evidence that the issue in question may represent a threat to public health, the report that emerges is unable to exclude the possibility.

Having reached this (inevitable) scientific impasse, politicians and scientists now unite around the 'precautionary principle'. Yet here again it seems that conceptions of this 'principle' differ between the two communities.

For the scientist, the precautionary principle, insofar as it is a principle or is even meaningful, suggests that when making cost-benefit analyses about particular courses of action, the response to inevitable uncertainties in some of the input data should be to act as if these data were a little more unfavourable than best guesswork currently suggests. As such it can act as a useful reminder of potential harm associated with technical innovation, especially when qualified by statements such as 'reasonable grounds for concern' as found in the OSPAR Treaty.[91] From this angle it is at its strongest when some partial scientific results, emanating from statistical studies or some early theorising, are available with respect to potential adverse effects. Conceived in this way the precautionary principle can help to improve the accuracy of utilitarian-style decision-making.

However, for the politician, and even more for the active opponent, the precautionary principle can serve as a way of emphasizing the worst-case scenario (however unlikely this may be) and thereby helping to slow down or entirely stop the activity in question. As the Phillips report has it, 'The importance of precautionary measures should not be played down on the grounds that the risk is unproven'. Once again we see a clash between the utilitarian ethic (and statistical *modus operandi*) of the scientist and the individualism of the politician and the activist.

Some commentators believe that the precautionary principle has had a deeper influence on decision-making in issues where supportive science and passionate opposition meet. In practice, the principle has had the effect of 'elevating public opinion over professional expertise and subordinating science to prejudice'[92]. An aspect of this has been the prominent role given to the relatives of the alleged victims of the pathogen in question, something that was a notable feature of media coverage of BSE. The utilitarian would argue that the tragedy of losing a close relative does not of itself yield any insight into the cause of a disease or how it should be prevented. The individualist would argue that this is what the whole issue is about – the effect on a (possibly very small) number of people – and so those directly affected should be accorded considerable influence over how the matter is managed.

As ever, it is not the aim of this paper to adjudicate between two different ethical world-views, even if such adjudication were possible. However, the role of the 'non-expert' is a rapidly expanding one. While once a committee or commission set up to look at a

[91] http://www.ospar.org/eng/html/sap/welcome.html, OSPAR, *OSPAR 2003 strategies*. OSPAR Commission for the Protection of the Marine Environment of the Northeast Atlantic, London, 2003.
[92] http://www.cf.ac.uk/socsi/news/dmap/papers/Durodie.pdf, W. Durodié, *The Demoralisation of Science*, King's College, London, 2003.

controversial issue would be populated by those with a track record of knowledge and publications in the field in question, it is now rare to find such a body being established without a much more catholic membership. Technical expertise often sits alongside expertise in social and philosophical issues, lay people, activists and those who have taken a radically different view from generally accepted theories, whether or not they can produce any evidence to support their positions. It is generally stressed that all participants sit on an equal basis.

MMR vaccine

If BSE established two key features of the way that the interface between complex science and society was managed around the turn of the century – an appeal to the worst case scenario and the inclusion of lay views, especially those of relatives of the alleged victims of the matter in question – many other controversies have embedded them.

The MMR vaccine is a combined vaccine for immunization against measles, mumps and rubella. It is usually administered to children around the age of one year, with a booster dose before starting school. It is widely used around the world – since its introduction in the 1970s over 500 million doses have been used in over sixty countries. Those receiving the vaccine may experience temporary side effects (e.g. a rash or a mild fever), though in about 1 in 100,000 cases there may be a more severe allergic reaction.

Vaccination against these diseases was one of the success stories of twentieth-century medicine. Measles infection rates were once so high that it is now assumed that anyone over the age of 55 years will have had measles at one time or another. Today rates among people under 30 in those countries with vaccination programmes are below 1 per cent. Globally the disease still accounted for over 750,000 deaths in 2000, more than half of these in Africa, but there was clear evidence that vaccination programmes could reduce these numbers significantly.[93] Mumps is another viral disease of childhood that used to be very common. In rare cases it can cause sterility among males. Rubella, or German measles, was also very common. The major risk in rubella is that if a pregnant woman is infected, this can lead to significant congenital defects in her baby. All three diseases are highly contagious.

The MMR vaccine was designed to be a single-shot vaccine that protects against all three diseases. Significant improvements in reducing the incidence of the diseases have been attributed to widespread use of MMR.

Controversy about vaccination began in the 1980s when a number of lawsuits were brought in the USA against manufacturers of vaccines, alleging that they had caused a variety of physical and mental disorders in children. While these were inconclusive, they did lead to a massive jump in the costs of the MMR vaccine as pharmaceutical companies sought to cover potential liabilities and some companies stopped selling MMR. However, in the UK concerns grew after the publication in 1998 of a paper by Dr Andrew Wakefield[94] which positeda connection between gastrointestinal symptoms and

[93] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5302a2.htm, Centres for Disease Control and Reduction, *Measles mortality reduction – West Africa*, *1996–2002*, 2003.
[94] A. Wakefield et al., 'Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children', *Lancet* vol. 351, 1998.

developmental disorders (e.g. autism) in twelve children who had been given the MMR vaccine. At a press conference (and in a video press release) before the paper was published Wakefield said that he thought single vaccines should be used until the MMR triple vaccine could be ruled out as a cause of the children's problems. Parents of eight of the twelve children studied were said to have blamed the MMR vaccine.

The press conference and video sparked a major health scare in the United Kingdom. The government and medical authorities such as the National Health Service (NHS) stressed extensive epidemiological evidence that failed to show any connection between MMR and developmental disorders. However, coming soon after the BSE controversy, these assertions were disbelieved by some parents and other interested parties. The take-up of MMR dropped from 92 per cent in 1996 to 84 per cent in 2002. In some parts of London it was said to be as low as 60 per cent, well below the rate needed to maintain 'herd immunity' and avoid a measles epidemic.

There were calls for the introduction of single vaccines. These were rejected by the government on several grounds – that the take-up rates of three separate vaccines would be lower than for a single dose of the triple vaccine; that single vaccines would be more expensive; but, most importantly, that the evidence strongly opposed the view that the MMR vaccine was a more serious health risk than single vaccination. Important recent studies supporting the viewpoint have included the following:

- October 2004 – a review financed by the European Union assessed the evidence given in 120 studies and concluded that while the vaccine was associated with some positive and negative side effects, it was 'unlikely' that there was a connection between MMR and autism.[95]
- January 2005 – intensive research in a single county in Minnesota concluded that there was no link between MMR and autism, and that an eightfold rise in the reporting of autism was due to an increased awareness of the disorder, a growth in services and changing definitions.[96]
- March 2005 – a study of over 30,000 children born in one district of Yokohama concluded that the rate of autism in children doubled after Japan abandoned the use of the MMR vaccine in April 1993. The authors' conclusion was, 'The significance of this finding is that MMR vaccination is most unlikely to be a main cause of Autistic Spectrum Disorders, that it cannot explain the rise over time in the incidence of ASD, and that withdrawal of MMR in countries where it is still being used cannot be expected to lead to a reduction in the incidence of ASD'.[97]

[95] http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12922131&dopt=Abstract, T. Jefferson, D. Price, V. Demicheli and E. Bianco, 'Unintended events following immunization with MMR: a systematic review', *Vaccine* vol. 22 (22 October 2004).

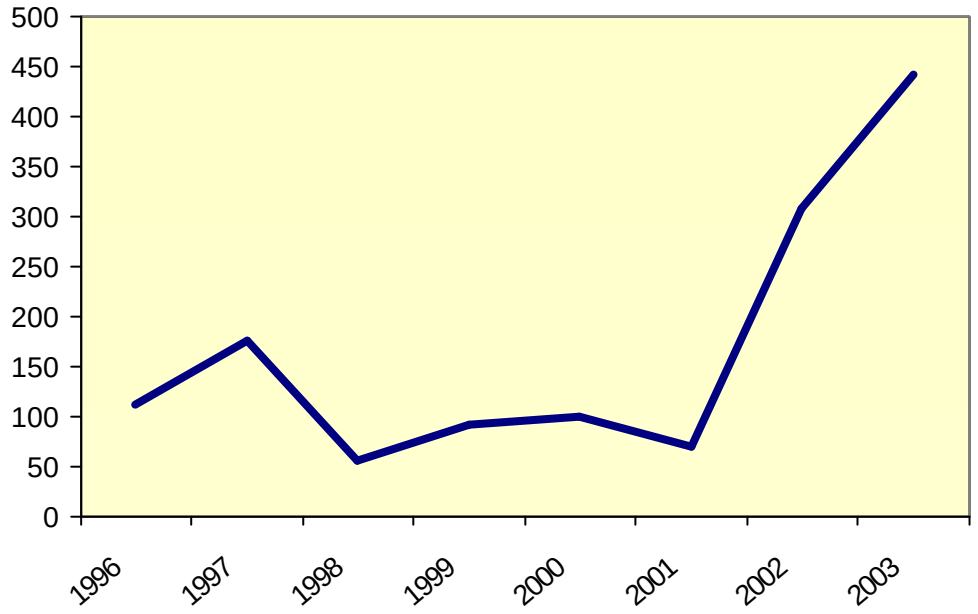
[96] http://archpedi.ama-assn.org/cgi/content/abstract/159/1/37, W. Barbaresi, S. Katusic, R. Colligan, A. Weaver and S. Jacobsen, 'The incidence of autism in Olmsted County, Minnesota, 1976–1997 – results from a population-based study', *Archives of Pediatric and Adolescent Medicine,* vol. 159 (1) (January 2005).

[97] http://www.blackwell-synergy.com/links/doi/10.1111%2Fj.1469-7610.2005.01425.x?cookieSet=1, H. Honda, Y. Shimizu and M. Rutter, 'No effect of MMR withdrawal on the incidence of autism: a total population study', *Journal of Child Psychology and Psychiatry and Allied Disciplines* **46** (6) (June 2005).

In February 2004 it emerged that at the time that Wakefield had published his report he was being paid £55,000 to help lawyers seeking evidence of a link between autism and the MMR vaccine. This was not revealed to either *The Lancet* or Wakefield's co-researchers. *The Lancet* subsequently said that it should have never published Wakefield's study because of his 'fatal conflict of interest' and some of his co-researchers also strongly criticized the lack of disclosure[98] – 10 of the 13 authors of the original *Lancet* paper formally retracted the claim of having found a possible link between MMR and autism.

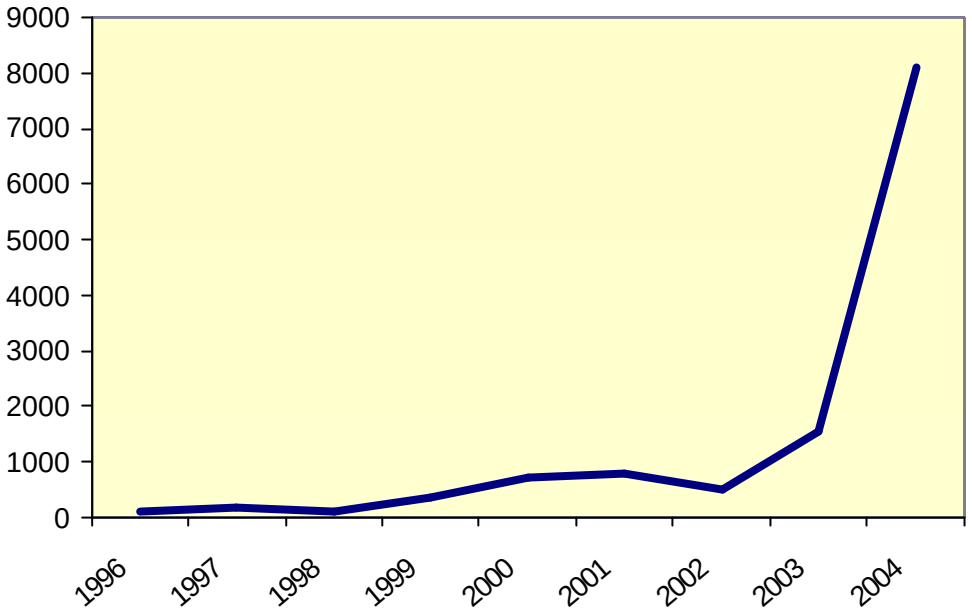
The effects of falling vaccination rates have been predictable. In 2003, the number of measles cases in the UK trebled to over 400, including at least three deaths. The increase in cases of mumps was even more dramatic, as Figures A2 and A3 show.[99]

Figure A2: Cases of measles, UK



[98] http://www.staffnurse.com/nursing-news-articles/mmr-autism-link-study-476.html, Staffnurse.com, *MMR-autism link study* (23 February 2004).
[99] http://www.hpa.org.uk/infections/topics_az/measles/data_mmr_confirmed.htm, Health Protection Agency, *Confirmed cases of measles, mumps and rubella 1996–2004,* London, 2005.

Figure A3: Cases of mumps, UK



Despite the evidence that any risks associated with MMR are very small, the dispute has followed a familiar course. The parents of children affected are given equal airtime (and understandably tend to be treated relatively supportively by interviewers and programme-makers) to express their views that MMR caused their children's problems, as are the researchers who apply scientific methods.

The commonsense view is, perhaps, that if problems emerge soon after an MMR jab then that jab is to blame. The scientific position, however, might be different. If over 90 per cent of children received the MMR vaccine, as was the case pre-1998, then by sheer chance it would inevitably be the case that some youngsters who sadly develop symptoms of autism would begin to show those symptoms soon after receiving their jab. Epidemiology, while a blunt tool in some ways, can at least offer some evidence as to whether children are more likely to develop autistic spectrum disorders soon after being vaccinated. Furthermore, if it were indeed the measles component of the MMR vaccine was associated with autism (as Wakefield claimed), then it is not clear why a separate measles jab should not cause precisely the same problems.

These arguments have rarely entered the public debate.[100] The affair would seem to be another example of a widespread phenomenon in developed countries, at least during times without serious apparent threats. 'Official' sources of information are disbelieved. (A particular political aspect of the dispute came when Prime Minister Tony Blair refused to confirm or deny whether his youngest child, Leo, had received the MMR vaccine, despite offering strong support for it in public. Chancellor of the Exchequer Gordon

[100] In an admirable TV programme broadcast in the UK in peak time on 4 August 2005 (*Should I worry about … jabs?*), journalist Richard Hammond reviewed the issue with respect to his own 18-month-old daughter. He was unable to find any scientific support for the supposed link between MMR and autism. However, one mother said, 'I don't feel happy about the MMR jab and nothing will persuade me otherwise,' while a survey suggested that only 1 per cent of the population trusted the government on health matters.

Brown was to act in the same way in 2004.) Indeed, as suggested earlier, a significant number of people actually seem to seek out reasons to get worried about very small risks and will believe even entirely unsupported claims by people who 'look right' and have no apparent vested interest in the issue. Our need to find causes to justify our personal and constant level of anxiety seems a powerful one.

One unusual feature, however, is that the British government, to some considerable criticism, stuck to its original policy, refusing to offer single vaccines. This was not a stance without risk – an ICM poll showed that 73 per cent of parents believed the vaccine was safe[101] but objections continued, presumably because of a perception that the government's stance was heavy-handed and paternalistic. Whether it will have any beneficial effect in terms of a recovery of vaccination rates in the longer term remains to be seen, but in the view of this author the government's position was refreshingly responsible. To have surrendered to the calls for single vaccines in the face of evidence that MMR was, in all likelihood, 'safe' would have been to open the door to subsequent claims that the measles vaccine itself was dangerous while making continued use of MMR impossible.

Mobile phones

By January 2004 there were one billion Global System for Mobile Communications (GSM) mobile phone subscribers across more than 200 countries. There are many other telecommunications and related systems in use, all of which result in exposure of the population to radiofrequency (RF) fields.

The extensive use of mobile phones suggests that users do not in general judge them to present a significant health hazard. Instead they have welcomed the technology and brought it into use in their everyday lives. Nevertheless, since their introduction, there have been concerns about the possible impact of mobile phone technologies on health.

In 1999 the UK government set up the Independent Expert Group on Mobile Phones (IEGMP) to review the situation. Its report, *Mobile Phones and Health* (the Stewart Report), was published in May 2000. It stated, 'The balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP (International Commission on Non-Ionising Radiation Protection) guidelines do not cause adverse health effects to the general population.' It did, however, offer a caveat: 'There is now scientific evidence which suggests that there may be biological effects occurring at exposures below these guidelines. We conclude therefore that it is not possible at present to say that exposure to RF radiation, even at levels below national guidelines, is totally without potential adverse health effects, and that the gaps in knowledge are sufficient to justify a precautionary approach. We recommend that a precautionary approach to the use of mobile phone technologies be adopted until much more detailed and scientifically robust information on any health effects becomes available.' Various subsequent reports from across the world have supported the main thrust of the Stewart Report's general conclusions.

As noted earlier, this is about as far as science can ever take us – no evidence of there being a problem but we must always bear in mind that evidence of that nature may emerge in the future so we need to be a bit careful. Subsequent experience has been

[101] BBC Radio Four (2002), *MMR vaccine – should we be given the choice?* (February 2002).

encouraging – the enormous increase in the use of mobile phones (doubling in the UK between 2000 and 2004, for example) has not been accompanied by any apparent increases in adverse health effects. Although there has been a small number of suggestions of longer-term effects, e.g. a Swedish study suggesting an increase in the risk of acoustic neuroma in people with more than ten years' use of mobile phones,[102] an Institute of Cancer Research study in 2005 carried out in the UK, Denmark, Finland, Norway and Sweden found no link between acoustic neuroma and the number of years that mobiles had been used, the time since first use, the total hours of use or the total number of calls, while recognizing that there was relatively little information concerning the risk of tumours after mobile phone use of more than ten years.[103]

However, public concerns and opposition in many countries have been directed not towards mobile phones themselves but towards phone masts (or base stations), despite the fact that the exposure from these is much less than from direct use of a phone. (Exposures in proximity to 'picocells' have been found to be no more than a few per cent of those given in/the maximum given in[?] safety guidelines for the public.) Major public protests have developed in response to particular applications to install phone masts, especially if they are near schools, hospitals or homes. Although in England and Wales the government issued an order whereby concerns over health could not be taken into account by local planning committees, many schemes were rejected on other grounds (visual intrusion, impedance of footpaths) or withdrawn by the proposers, leaving some areas (even in large cities) effectively without network coverage.

The phone mast controversy is another example of government (and industry) action serving not only as a response to public fears but also as a significant force in shaping those concerns. 'Almost by definition, what is a risk issue is itself determined by the extent and character of government reaction. There is also a more particular sense in which official risk responses potentially animate and cohere diffuse anxieties'.[104] Far from heading off potential accusations of complacency through a proactive strategy to 'keep ahead of public anxiety', as had been claimed by Industry Secretary Tessa Jowell, the UK government's precautionary action in establishing IEGMP seems actually to have stimulated risk concerns (which increased after the inquiry). It seems that even balanced public information on negligible risks tends to increase anxiety on the assumption that 'there must be something to worry about if the government is taking action'.

Although the Stewart Report acknowledged that 'the balance of evidence does not suggest that mobile phone technologies put the health of the general population … at risk', nevertheless the study called for a £7 million programme of further research and for leaflets to be included in future purchases of mobile phones warning of the possible risks. According to one commentator, 'In its rush to be open about communicating risk

[102] http://www.imm.ki.se/PDF/Press%20release%20Oct%2013%202004.pdf, S. Lönn, A. Ahlbom, P. Hall and M. Feychting , 'Mobile phone use and the risk of acoustic neuroma', *Epidemiology* **15,** 653–9 (13 October 2004).
[103] http://www.nature.com/bjc/journal/vaop/ncurrent/abs/6602764a.html, M. Schoemaker et al., **'**Mobile phone use and risk of acoustic neuroma: results of the Interphone case-control study in five North European countries', *British Journal of Cancer* vol. 93 (5) (30 August 2005).
[104] A. Burgess, 'Comparing national responses to perceived risks from mobile phone masts', *Health, Risk and Society* **4** (2) (June 2002).

to the public, the government has simply forgotten that there was no risk to communicate'.[105]

The leaflets also advise taking note of the specific absorption rate (SAR) of phones, which measures their heating effect, despite all sides to this argument accepting that such heating is not the problem. This suggests that recording anything that was easy to measure became the key concern, irrespective of the fact that it did not relate to the (still-to-be-demonstrated) 'non-thermal' effects.[106]

The Stewart inquiry, then, once again seemed to make significant concessions to the need to incorporate perceived public concerns and even prejudice. Following the recommendations in the report, future research will be required to take account of non-peer-reviewed and anecdotal evidence. Indeed, in the view of some commentators, the inquiry itself served to magnify such concerns by extending its remit beyond a review of the latest scientific knowledge on mobile electromagnetism to the non-scientific terrain of concerns pertaining to the siting of masts or base stations.

Asbestos

Asbestos is the name given to a group of minerals that occur naturally as masses of strong, flexible fibres that can be separated into thin threads and woven. These fibres are not affected by heat or chemicals and do not conduct electricity. For these reasons, asbestos has been widely used in many industries. Four types of asbestos have been used commercially:

- chrysotile, or white asbestos, by far the most common;
- crocidolite, or blue asbestos;
- amosite, which has brown fibres;
- anthophyllite, which has grey fibres.

Among the more than 5,000 products that contain or have contained asbestos are:

- asbestos cement sheet and pipe products used for water supply and sewage piping, roofing and siding, casings for electrical wires, fire protection material, electrical switchboards and components, and residential and industrial building materials;
- friction products, such as clutch facings, brake linings for automobiles, gaskets, and industrial friction materials;
- products containing asbestos paper, such as table pads and heat-protective mats, heat and electrical wire insulation, industrial filters for beverages, and underlying material for sheet flooring;
- asbestos textile products, such as packing components, roofing materials, and heat- and fire-resistant fabrics (including blankets and curtains);
- ceiling and floor tiles; gaskets and packings; paints, coatings, and adhesives; caulking and patching tape; artificial ashes and embers for use in gas-fired fireplaces; plastics.

[105] http://www.spiked-online.com/Printable/0000000053FA.htm, J. Kaplinsky, *Mobile Moans*, Spiked Science, 2000.
[106] http://www.cf.ac.uk/socsi/news/dmap/papers/Durodie.pdf, Durodié, *The demoralisation of science.*

It is well established that exposure to asbestos may increase the risk of several serious diseases, including asbestosis (a chronic lung ailment that can produce shortness of breath, coughing, and permanent lung damage), lung cancer, mesothelioma (a relatively rare cancer of the thin membranes that line the chest and abdomen) and other cancers, such as those of the larynx, oropharynx, gastrointestinal tract and kidney.[107]

However, the debate in France and elsewhere, in the view of many commentators, resulted in an overreaction which at best wasted resources and at worst, in the words of the US Court of Appeals, may have resulted in adverse overall health consequences. For example, white asbestos, the most common, seems rather less dangerous than blue asbestos and it may be a better policy to leave white asbestos in unbroken and covered tiling, say, than to drill it out, causing dust and a potentially greater health hazard.

The public controversy over asbestos in France can perhaps be traced back to the publication in 1993 of the Ban Asbestos coalition's manifesto, *Le livre noir de l'amiante* (*The Asbestos Black Book).* The document called for a world-wide ban on all asbestos mining, manufacture and use, as well as the immediate and universal removal of all in-place asbestos materials.

In July 1994 there were reports of several teachers in France dying of lung cancer after having worked in buildings containing asbestos insulation materials at low densities. The theme was taken up by the mass media via a number of alarming reports on the potential risks of exposure. The wives of the teachers involved subsequently initiated charges of involuntary manslaughter.

Later that year, at Jussieu University in Paris, the presence of asbestos insulation materials raised concerns over the safety of building workers and general occupants. This resulted in the creation of the Comité Anti-Amiante Jussieu, (the anti-asbestos committee) which became increasingly vocal in publicizing the alleged the hazards of 'asbestos-contaminated air'. The CAAJ organized meetings in which figures such as British epidemiologist Julian Peto outlined projections of increased mortality rates amongst building maintenance and repair workers exposed to asbestos.

Asbestos became an issue in the 1995 French national elections when several public interest groups joined forces to speak of its dangers, of the need for new preventive measures to control its use in buildings and of the case for a total ban of its manufacture and use. They urged the government to act quickly and forcefully to remedy the situation. An article in the widely read publication *Sciences et Avenir* described asbestos insulation materials in place in public and commercial buildings as 'a deadly epidemic which affects all of us'. The article accused French industry and government officials of collaborating to hide the true risks of asbestos from the French public.

In July 1995 the newly elected government engaged research group INSERM to carry out a detailed review of the health risks associated with asbestos exposure 'based on internationally published scientific literature'. However, in September of that year a television programme entitled *Mortel Amiante* (*Deadly Asbestos*) was aired. As in the *Sciences et Avenir* article (taken almost verbatim from the anti-asbestos groups), the hazards related to workers installing friable insulation in the past, the risks of different

[107] http://cancerweb.ncl.ac.uk/cancernet/600321.html, National Cancer Institute, *Asbestos exposure: questions and answers,* 2002.

fibre types, the exposures in occupational settings and the exposures in buildings were all treated together, leaving readers with the impression that all types of asbestos fibres and products presented a grave risk to the general public and workers. In response to this pressure the French government announced new legislation requiring the development of a country-wide registry of buildings containing asbestos and a plan for the monitoring and management of in-place materials.

Early in 1996 a victims' rights group, ANDEVA, was formed to increase pressure on the government to institute a ban and to seek compensation for those who had come forward as victims of asbestos-related disease. In June ANDEVA issued a civil law suit which accused asbestos industry officials, technical and scientific consultants as well as French government officials of having conspired to delay the introduction of new, more stringent regulations on asbestos in buildings as well as to delay the ban of all uses of asbestos despite knowledge of its inherent health risks.

A preliminary summary of the INSERM report was released to the public and media on 2 July 1996. It estimated that the number of asbestos-related deaths by mesothelioma and lung cancer in France could approach 1,950 in that year. The following day, after convening an emergency cabinet meeting to discuss the conclusions of the INSERM report, the government of France announced its decision to ban the manufacture, import and use of almost all asbestos-containing products, effective 1 January 1997.

France was not the only country to seek to ban asbestos – in 1989 the Environmental Protection Agency (EPA) in the USA proposed a similar ban. However, the proposal was struck down by the Court of Appeals in 1991 (except for the parts banning, as of 1990, new manufacture of some asbestos-containing products that were no longer being manufactured in 1989). The Court of Appeals found, *inter alia,* that:

- EPA's conclusion was based on 'the failure of EPA to consider all necessary evidence' and 'to give adequate weight to statutory language requiring it to promulgate the least burdensome, reasonable regulation required to protect the environment adequately';
- EPA had failed 'to calculate the cost and benefits' of 'each regulatory option', as it is required to do to determine whether 'any other regulation would achieve an acceptable level of risk';
- EPA had failed 'to evaluate the harm that will result from increased use of substitute products', many of which, the Court noted, contained carcinogens, with the result that the ban 'actually may increase the risk of injury Americans face';
- 'EPA's willingness to argue (for) spending $23.7 million to save less than one-third of a life reveals that its economic review of its regulations, as required by Toxic Substances Control Act, was meaningless';
- EPA's procedures were inadequate because they 'failed to give notice to the public' of the exposure estimates that it 'used to support a substantial part' of its role – the Court found this last flaw sufficient in and of itself to invalidate EPA's proposal.

Once again, however, it seems that the door to exaggeration was opened by a complacency among some scientists working in the field, with the effect that trust in regulatory bodies was undermined. The tendency to place too much confidence in

'soundly based scientific analysis' which may subsequently appear to be neither scientific nor rigorous is a common feature of such controversies.

Radioactive waste management and low-level radiation

It seems reasonable to argue that, for the nuclear energy industry, it is the fear of radiation (whether proportionate or not) which has served as the most serious obstacle to public and political acceptance.

There is considerable dispute as to the real risks associated with exposure to low-level radiation and it is beyond the scope of this paper to comment on that debate. Above 100 mSv (milliSievert) exposure it is accepted that health effects of exposure can be detected. Below such doses, positions range from one of mild hormesis – that low-level radiation serves to protect from development of cancer by keeping the body's defences 'topped up' – to a claim that radiation is considerably more dangerous than the internationally-accepted risk factors as promulgated by the United Nations.[108] It is accepted that natural sources of radiation, accounting for an average of 2.3 mSv per person per year in the UK, dominate exposure (artificial sources together accounted for 0.4 mSv in 2003, most of this coming from the use of radioactive materials in medicine[109]), though there is some debate as to whether some artificial sources of radiation may be more damaging than currently believed. One might argue, however, that if radiation were a major risk at background levels then this would become clear, given such observations as the fact that radiation exposure in high granite geologies, for example, is much higher than the national average, with no apparent associated health detriment.

The literature on how we perceive risk is voluminous. It has tended to focus on two aspects: the social context in which risk is communicated and perceived (issues such as trust, equity of distribution of risk etc., which have been considered in the main body of this paper) and the nature of the risks themselves.

Work carried out in the early 1980s in Oregon investigated the factors that [at work?] between calculated risk, as determined by Probabilistic Safety Assessment (PSA), and public perceptions of risk.[110] (Probabilistic Safety Assessment, in effect, makes estimates of the risk associated with a particular activity by examining the dangers the activity has represented in the past. Results are often quoted in terms of 'deaths per mile', 'injuries per hour', etc.)

The Oregon Study asked various groups of people to rank thirty potential risks in order of severity. The correlation between public perception of risk and the calculated risk was in general very good. However, in some cases there were considerable discrepancies. For example, college students ranked swimming as the least serious of the risks (below, for example, food colourants and hunting), while in reality over 100 swimming deaths

[108] http://www.unscear.org/pdffiles/annexg.pdf, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) , *Sources and effects of ionising radiation – Annex G*, UNSCEAR, New York, 2000.
[109] http://www.hpa.org.uk/radiation/publications/hpa_rpd_reports/2005/hpa_rpd_001.htm, S. Watson, A. Jones, W. Oatway and J. Hughes, *Ionising radiation exposure of the UK population: 2005 review*, Health Protection Agency (HPA-RPD-001), 2005.
[110] P. Slovic, B. Fischhoff and S. Lichtenstein, 'Facts and fears; understanding perceived risk' in R. C. Shwing and W. Albers (eds), *Societal Risk Assessment: How Safe is Safe Enough?*, Plenum, New York, 1980.

occur each year in the USA. By contrast, all groups put nuclear power near the top except the PSA experts, who placed it twentieth.

There seem to be three factors which act in May when we convert 'real' risk into 'perceived' risk. The first is associated with familiarity. If a risk is an old, well-established one, familiar to the individual and easily detectable by unaided human senses, it will tend to be underestimated relative to a risk of the same actual magnitude which is new, unfamiliar and difficult to detect.

The second concerns controllability. If a risk is run voluntarily and is easy to control, it will be perceived as less serious than one which is imposed on people and is difficult to control. (Note that this is not just a matter of the *acceptability* of a self-imposed risk against one imposed on us, but of the perception of the actual *severity* of the risk itself.)

The third concerns the number of people affected by the risk. If a risk presents a small chance of injury to a large number of people (especially future generations) it will be perceived as more serious than a risk which has the same overall health effect, but where one can identify the likely victims.

Car travel, responsible for some 3,500 deaths each year in the UK, lies near one extreme of all three factors. We are all familiar with car travel, having (by definition) taken part in this activity without suffering a fatal accident. We choose to indulge in it, and we all know that we are better drivers than the majority and so are less likely to suffer an accident. Finally, although there are many deaths on the roads, it is always possible to identify the victims. Many fatal road accidents –by contrast to, say, rail or air accidents – do not attract national media interest; this presumably serves to 'hide' them to an extent and so reduce the anxiety that might otherwise have been caused.

Nuclear power appears at the other extreme. It is a new risk. Radiation is not detectable by unaided human senses, and in a number of countries most people usually see images of nuclear stations in negative contexts, the mass media generally preferring 'bad news' stories to good ones. It seems to be 'imposed' on local communities and on society at large; few people choose, or would choose, to have a nuclear power station built nearby in the sense that they choose to go for a drive. And although nuclear accidents are rare (and there has been only one with demonstrable off-site health consequences caused by radioactive releases), the impression is that a single extreme event could affect large numbers of people, perhaps everyone on earth and for many generations, maybe even interfering with the genetic stuff of life itself. Many individuals in northern Europe, for example, were aware that fallout from Chernobyl fell on their homes, especially during rainfall, during the week after the accident.

As a result, nuclear power tends to cause more unease than motor transport, even among some people who suspect they are being 'irrational', in the same way that air travel tends to cause more anxiety than car travel, at least for many less frequent travellers.

However there are other reasons why rational individuals might have no wish to see a radioactive waste repository near their home. Like any large industrial operation there will be implications for road transport, noise and environmental degradation, with potential knock-on effects on house prices, tourism and general enjoyment of a quiet life.

These concerns will need to be incorporated into the decision-making process at some stage.

A widespread view seems to exist that involving a wider range of interested individuals at an earlier stage – it is sometimes referred to as 'front-loaded consultation' – will lead to better decision-making. Supporters point to the case of radioactive waste management policy in Scandinavia, in which a slow approach with strong emphasis on building trust has resulted in robust proposals which appear to be implementable. However, recent experience in the policy area of radioactive waste management and the health effects of low level radiation exposure in the UK is illuminating.

The history of attempts to find a site for long-term disposal of radioactive waste in the UK is long and fraught, and is discussed in more detail in Appendix 1. It is characterized by identification (behind closed doors) of a possible site or sites (Billingham in the early 1980s, four sites in England in 1986/7, Sellafield in the 1990s) followed by local outrage and campaigns and the withdrawal of the proposal, often soon before a general election is called. (The four sites were abandoned on 1 May 1987, a fortnight before the election was called; Sellafield was abandoned on 17 March 1997, on the same day the election was called.)

The combination of a lack of serious consultation before the decision is announced and panic reactions to public responses afterwards is a particularly unfortunate one. (Lord, Jenkin, Secretary of State for the Environment 1983-5, says that in the 1980s the main paradigm of decision-making shifted from the 'DAD' model – decide-announce-defend – to the 'DADA' model – decide-announce-defend-abandon.) It seems that political cultures which either engage people earlier and more seriously (as seen in Scandinavia) or which take their decision and then stick to it through whatever storm of protest and legal action may follow (the USA over Yucca Mountain) may both be more successful in creating policy that can be implemented.

Be that as it may, the incoming Labour government in 1997 found itself in an impasse. Sellafield, the site most attractive in terms of public support, had been rejected and there were no other options on the table. Every unsuccessful attempt to solve the problem had led to a heightening of public concerns. In the absence of any very serious likelihood of a new build programme (which might require some clear understanding as to how waste would be managed) there was no very pressing rush to come up with new proposals.

The government set up the Committee on Radioactive Waste Management in 2003, following a political process characterized by considerable delay. (The then Environment Minister Michael Meacher promised a Green Paper for discussion by the end of 1999[111] – it eventually emerged in late 2001.) Its main task was to review the options for managing the UK's radioactive wastes and recommend the option, or combination of options, that could provide a long-term solution which protects people and the environment. Its priority was to recommend how to manage the wastes for which no long-term management strategy currently exists – i.e. wastes of high and intermediate levels of radioactivity which were in storage or likely to arise over the next hundred or more years and some low-level waste unsuitable for disposal at the Drigg

[111] http://www.ukceed.org/consensus_conference/responses.htm , UKCED, *Responses to the Citizen's Panel report, National Consensus Conference on Radioactive Waste,* 1999.

site in Cumbria. CoRWM was asked to make recommendations to Ministers by July 2006.

CoRWM stated: 'We are keen to engage with a wide range of people, and to make sure that we take full account of the range of public, stakeholder and specialist insights and concerns.' Its initial membership of 13, under the chairmanship of Dr Gordon MacKerron (a distinguished academic who had previously carried out a considerable amount of work for Greenpeace and other antinuclear pressure groups but whose work is widely respected) included antinuclear activists (a former Chairman of Greenpeace and a chief policy adviser to the Nuclear Free Local Authorities), a former nuclear industry employee and several academics.

> Tensions within the membership of the group reached breaking point. Particularly trenchant critics were Dr Keith Baverstock, formerly of the World Health Organization, and Professor David Ball of Middlesex University. In April 2005 Ball (who had previously requested that he be suspended from the Committee and was subsequently to resign) wrote to the then Environment Minister complaining about the political 'spinning' of the waste issue. He complained that some members of CoRWM had little knowledge of or were hostile to the use of expert knowledge in public policy decision-making and that in its place was what appeared to be a misplaced confidence in 'in-house amateurism'. The taxpayer would therefore be faced with a very large bill while continuing to be unnecessarily exposed to risk because Britain's nuclear waste was stored sub-optimally. 'My impression of CoRWM is of an agency deciding the fate of hazardous material, thought by some to be the most dangerous in the world, in the way that one might decide on the location of next year's village fête. This dangerous and surreal fantasy, which I consider substitutes expertise with insubstantial PR gloss, is totally out of kilter with all known government and regulatory advice on decision-making.[112] (The Chairman rejected the criticism, saying that 'it is not our fault if we are the wrong committee, we didn't appoint ourselves, but there is a clear science and technology background within the membership of the committee'.[113])

Ball and Baverstock both faced difficulties because of their position. Ball said both of them 'had an uphill struggle to get any respected expertise, scientific or otherwise, injected into the CoRWM process.' Baverstock was subsequently dismissed from the Committee by the Minister, having previously been suspended.[114] The House of Lords Select Committee on Science and Technology expressed 'concern [at] the suspension of one member of CoRWM, Dr Keith Baverstock, and the request of another, Dr David Ball, that he too be suspended from the committee. We have already stated our concern as to the level of expertise on CoRWM; it would be extremely unfortunate if this expertise

[112] http://www.mdx.ac.uk/news/corwrm.htm , Middlesex University website, *HSSc professor expresses concern over government's handling of nuclear waste disposal,* May 2005.
[113] http://www.neimagazine.com/story.asp?storyCode=2028242, *Nuclear Engineering International* (20 April 2005), 'CoRWM fends off critics'.
[114] In June 2005 the CoRWM website made no reference to Dr Baverstock's removal nor direct reference to his former membership.

were further diluted through the loss of two members with relevant technical experience.'[115]

Lest it be inferred that the blame for failure to progress lies with government and regulators alone, the nuclear industry has certainly played its part in many countries. It is not uncommon to hear proponents of nuclear energy argue that intermediate levels of waste are about as dangerous as petrol or paint stripper – potentially hazardous but safe if handled properly – but go on to say that they should be buried some 800 or 1,000 metres underground. The public and political response to this is entirely predictable: we do not treat anything else that we produce in this way so clearly this waste is the most dangerous material ever produced; furthermore, if the nuclear industry is pretending such waste is relatively harmful (despite its own proposals), then it is insulting our intelligence and we will not believe anything else they try on with us. Echoing Burgess's sentiments discussed above, the nuclear industry seems not to have realized that every time it makes things a bit safer it does not put people's minds at rest but causes them extra concern – the material must be a bit more dangerous than the industry had realized, or than they were prepared to admit, before.

One can identify other areas in which the actions of the 'scientific community' have exacerbated matters.[116] Organizing interdisciplinary expertise is a major challenge as specialist scientists seem to sink ever deeper into their own silos. The absence of individuals who can identify the 'big picture' in a complex field and serve as a bridge between the specialists in each discipline or sub-discipline serves as a barrier both to the internal communications necessary for a fruitful exchange of views and theories, and to the explanation of the implications of the technology as a whole to wider society. There are signs that some attempts are being made to counter this (e.g. various public participation initiatives in France, discussed in Appendix 1, and the UN Intergovernmental Panel on Climate Change).

A more extreme example of a committee collapsing in disarray had occurred a few months earlier. CERRIE (the Committee Examining Radiation Risks of Internal Emitters) was established in 2001 at the direct request of Michael Meacher, himself a long-term antinuclear campaigner[117] (though at that time constrained by collective responsibility as a member of the government. It included considerable representation from the antinuclear movement as well as a representative of the nuclear industry and several academics and regulators. Remarkably, this group succeeded in producing a report to which most members could subscribe. However, for reasons that are not clear, the membership included two individuals from one very small organization (the Low Level Radiation Campaign) who had no track record of publication in the field and whose unpublished work, when released to the media, had been severely criticized by

[115] http://www.parliament.the-stationery-office.co.uk/pa/ld200405/ldselect/ldsctech/89/8903.htm, 'Radioactive waste management – the Committee's commentary on the government response', *House of Lords Select Committee on Science and Technology Second Report* (March 2005).

[116] Indeed, one can challenge whether the 'scientific community' is so diverse within itself as to render the term meaningless. In the view of this author, one can identify a body of individuals who share a general approach to scientific investigation, though not, of course, always agreeing on any particular hypothesis. There are, however, many good scientists who hold radically different views about the nature of science and its proper place in society.

[117] In 1987, as Opposition spokesman on health, he said children living near nuclear installations 'have literally grown up in killing fields'. Cited in http://ej.iop.org/links/q79/TkHr+Erxvle3U4,3O4P0cw/jr44e1.pdf, R. Wakeford, 'Reflections on CERRIE', *Journal of Radiological Protection* **24** (4) (December 2004).

regulatory health bodies.[118] These individuals disagreed vehemently with the rest of the Committee (including, most acrimoniously, with the other antinuclear campaigners – their chief bile was reserved for Dr Ian Fairlie, closely associated with antinuclear pressure groups) and refused to sign up to the final report in October 2004. Interestingly, the row which surrounded this disagreement served to divert attention away from a report which on first reading seemed to offer some support to the views of the moderate anti-nuclear movement.

[118] The Low Level Radiation Campaign claims ownership for the idea of CERRIE and implies that it was set up by Meacher specifically to publicise their views. 'During arguments about the Euratom Directive and the LLRC campaign to oppose transposition of the nuclear waste charter into UK law, LLRC developed a dialogue with the UK Environment Minister, Michael Meacher. Following meetings with Chris Busby, Richard Bramhall and Molly Scott Cato, the Minister agreed to set up, jointly with the Department of Health, a new government committee whose remit would be to examine disagreements about the safety of the health risk models which presently underpin the regulation of discharges of man-made radiation to the environment.' Meacher, by then out of office, wrote a supportive foreword for Busby and Bramhall's 'Minority report'. http://www.llrc.org/, LLRC, 'Committee Examining Radiation Risk from Internal Emitters (CERRIE) – a new model of scientific advice gathering for Government: the progress and the problems', *RadioActive Times* **5** (1) (June 2003).

APPENDIX 3: UTILITARIAN AND RIGHTS-BASED (KANTIAN OR CONTRACTARIAN) ETHICS

Some differences between these two moral theories, as they refer to issues such as nuclear energy, can be listed as follows.[119]

Utilitarian	Rights-based
Basic positions	
What is right is what promotes the best consequences for the most people.	All people have rights to live without having risks imposed on themselves (even if these risks also bring considerable benefits for other people) and to be protected from any risks that are so imposed.
The economic consequences of different safety standards and ethical positions are centrally important – resources spent in one way are not available to improve people's lives elsewhere.	Any risk is justified only with individual consent, compensation and equality of risk distribution.
Are risks ethically acceptable if they are they are at the same level as voluntarily chosen risks?	
Yes – the public should be consistent and accept risks that are lower than those associated with such activities as road travel. Risks have to be weighed against benefits.	No – it is not just a question of risk magnitude, but also of distribution and compensation. The risks associated with nuclear reactors or a radioactive waste repository, say, are perceived to be more catastrophic, less compensated and under less voluntary control than many other risks.
'Natural (existing) standards' are used as the basis for determining safe level of other pollutants and should also be with radiation.	Assuming a level of risk is ethically acceptable because it is 'normal' commits the naturalistic fallacy: we cannot derive 'ought to be' from 'is'.
Risk can be defined as a probability of some harm. Risks are quantitative and thus comparable.	Risk is also a function of qualitative components such as the degree of consent of individuals who may potentially be affected.
Uncertainty and ethical standards: should those who impose risk be presumed innocent until proven guilty, or the opposite?	
Policy should follow a rule of maximizing average expected benefit. Worst cases are very rare; minimizing the risk of their occurring or their consequences absorbs resources which would provide more benefits elsewhere.	Policy should follow a rule of avoiding the worst possible outcome. A small (close to zero) probability of catastrophe does not outweigh infinitely serious consequences.
Policy should follow the scientific norm of minimizing 'false-positives' (i.e. concluding there was harm due to exposure when there was not). It should not be assumed	Policy should follow a norm of minimizing false-negatives (concluding there was no harm when there was). Fairness and the right to equal treatment require those

[119] Derived from K. Shrader-Frechette, 'Nuclear power', in R. Chadwick (ed.), *Encyclopaedia of Applied Ethics* **3***:* 343–51, Academic Press, San Diego, 1998 – see http://www.ac.wwu.edu/~gmyers/ehe/ethicradwaste.html.

Utilitarian	**Rights-based**
that BSE-infected beef, the MMR vaccine or radiation, say, caused an injury unless all other causes can be ruled out. The burden of proof must be on the alleged 'victims' as it is too costly to do otherwise.	imposing a risk should have to prove (or at least demonstrate to a high degree of likelihood) that the activity in question does not and will not cause injury.
Equity issues	
The basic premise of equity among various groups is agreed but costs for the future can be discounted owing to the uncertainty involved, e.g. the likelihood of finding solutions to problems which today have no such apparent solutions.	Temporal and spatial considerations are not a morally relevant basis for discriminating in imposition of risks, so no discounting for geography or time should be allowed.
Poor communities that accept risks do so voluntarily – economic development benefits and wage differentials compensate for the risks to workers.	It is unfair disproportionately to burden these communities. Economic welfare does not justify such inequalities, as the human right to equal protection is inviolable.
Consent – is inequitable distribution of risk allowable, if parties consent?	
Economic development and risk-for-money trade-offs serve the greater good. Lower standards can be applied if there is informed consent. In any case no instances of consent are perfect. Sociological differences are relatively unimportant.	A stringent concept of consent should be applied. Consent must be informed and educated and those involved must have alternatives. (Generally, it is argued, those with most of the[?] above tend not to consent to controversial industrial developments such as nuclear power plants; those least informed and without alternatives are the ones who end up having such developments foisted on them.) Poor people should not be allowed to trade their basic health for jobs, whatever the level of compensation. How can future generations give consent?
Due process and compensation	
It is agreed that compensation is required to justify imposing higher risk.	Even where higher risk is potentially acceptable (i.e. where the consequences of this risk are not too high to make it unacceptable), compensation is required to justify imposing it, since lack of compensation harms victims by threatening their rights to due process. The acceptability of industrial risks (e.g. those associated with a nuclear power station or waste repository) is a function of compensation.
Some feel that if a facility is safe then risk-imposers have little to lose by accepting full liability for accidents.	People are often concerned about small, uncompensated risks too. Industry and government liability is limited to less than costs of worst-case accident, which violates the principle of the risk-creator providing compensation. If we cannot guarantee future generations will be compensated, we cannot justify imposing risk. Forms of compensation

Utilitarian	**Rights-based**
	include financial funding, acceptance of liability and community control of health and safety monitoring.
Modes of political activity and attitudes towards institutions	
Traditional democracy is the best way to ensure that the interests of society are translated into appropriate policies. Technical 'experts' have a vital role to play in ensuring that policies are devised which will deliver the population's requirements as expressed through the political system. 'Direct action' is often simply a way of imposing the views of small minorities on society at large.	Traditional elective democracy is often unable to protect the rights of individuals or small groups. 'Don't vote, it only encourages them – they are all the same anyway.' 'Experts' should have no greater input to decision-making than those who will have to live directly with the consequences of those decisions. Deference to 'the great and the good' is an outmoded and entirely inappropriate attitude for a modern society. Local direct action is often justified as a way of protecting individual rights.

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