Nuclear Objections_6 **Gordon Taylor** **2007-10-17**

In the nuclear consultation document, Paragraph 35 states that 'Our (the Government's) preliminary view is that preventing energy companies from investing in new nuclear power stations would increase the risk of not achieving our long-term climate change and energy security goals, or achieving them at higher cost'. (http://www.berr.gov.uk/files/file39197.pdf).

The objections to allowing new nuclear power stations are grouped under Safety Risks, Performance Risks and Financial Risks.

SAFETY RISKS

1) The consequences of the maximum radioactive release are not stated.

There is no mention of any Reactor Safety Study for the U.K. Yet following Chernobyl, common decency and 'due diligence' requires such a study to inform the citizens of the UK and neighbouring countries – including the energy companies - regarding the safety risk. This is expressed as probability times consequences. However, due to unanticipated events, any estimate of probability must be too low, and by an amount that is not just unknown, but logically unknowable. Hence attention must be focussed on the consequences of the maximum radioactive release. This was recognised in the Swedish Reactor Safety Study of 1978. According to this analytical study, the consequences range up to 100,000 prompt human fatalities and a contaminated area of 10,000 to 100,000 km2. (See 'Swedish Reactor Safety Study: Barseback Risk Assessment', Industridepartmentet, Energikommissionen, Ds I 1978:1 Pages 1-2, 1-11, 2-6, 2-13). The areas of radioactive fallout from Windscale and Chernobyl are also indicative. (See http://news.bbc.co.uk/1/hi/sci/tech/7030536.stm and http://en.wikipedia.org/wiki/Chernobyl_disaster#International_spread_of_radioactivity). As empirical confirmation, the area of Europe contaminated by radiocaesium from Chernobyl was over 200,000 km2. (See http://www-pub.iaea.org/MTCD/publications/PDF/Pub1239_web.pdf Page 2). These areas may be compared with that of the UK at 244,000 km2. Moreover, at Chernobyl a nuclear explosion of three to five megatons was narrowly averted. This would have meant that not only Kiev and Minsk, but a large part of Europe would have been uninhabitable. (See http://www.guardian.co.uk/ukraine/story/0,15569,1469597,00.html) and 'Voices from Chernobyl', by Svetlana Alexievich, ISBN 1-56478-401-0, 2005, Page 136). With such consequences, the only safe probability is zero, which means no nuclear power. Most Western states either have no nuclear power or are phasing it out.

Paragraph 6.19 says that 'The NII is not in a position to substantiate safety claims for reactor safety before it has a chance to carry out detailed assessments'. However, as noted above, assessment can be limited to the maximum consequences. For these, the 'source term' is dependent principally on the reactor size and fuel load and much less so on the plant design. Before nuclear power is considered any further, the National Radiological Protection Board/Health Protection Agency should carry out such a study and publish their methodology and results - to enable 'peer review'. They might make use of the MARC (Methodology for Assessing the Radiological Consequences of Accidental Release of Radionuclides to Atmosphere) or CRAC2 (Calculation of Reactor Accident Consequences) programs or one of their successors.

Paragraph 80 discusses the transport of nuclear materials. While the nuclear power plants (NPPs) are on the coast, some distance from the major conurbations, the transport arteries, both road and

rail, pass through the major conurbations. Moreover, transport is inherently more vulnerable to accident or attack. Hence a given radioactive release may have greater consequences. Regarding the risk, the probability is unknowable, so only the consequences matter. (See above). Paragraph 75 says that the consequences are 'severe and wide-ranging'. This is unacceptable, so nuclear power must be excluded, and nuclear transport thereby limited to decommissioning the legacy plants.

There is insufficient concern for the safety of the citizens of the UK and neighbouring states, most of which have no nuclear power or are phasing it out. After publication of the Reactor Safety Study, the Government must obtain the concurrence of all countries that have been or could be affected by radioactive releases – both operational and catastrophic – from the UK. This must include each individual member state of the EU and the population of the UK by referendum. This would be only fair before facing them with the continuing threat of radioactive pollution, injury or death.

There is no mention of measures to mitigate the consequences of another major radioactive release, despite the experience of such releases from Windscale and Chernobyl. Iodine tablets are the most effective means of protecting the human thyroid – particularly of children - from the uptake of radioactive iodine. However, they must be taken immediately after the release. (http://www.who.int/entity/ionizing_radiation/pub_meet/en/Iodine_Prophylaxis_guide.pdf). The nuclear operating companies must pay for but the Government must supply iodine tablets free of charge to everyone in the UK and other countries thereby put at continued risk. This must be accompanied by a recurring publicity campaign regarding their use following a radioactive release.

In the light of Windscale and Chernobyl, a foreign policy of the U.K. should be to work for the rapid phase-out of nuclear power worldwide, due to the evident unacceptable risk to humankind. Moreover, rather than contributing to the refurbishing of overseas nuclear facilities, these should be shut down and replaced by energy saving and renewable options that are far safer and sustainable.

2) The nuclear proposal is misrepresented as being favourable to the environment

Paragraph 105 says that 'Industry has indicated that the most viable sites are likely to be adjacent to existing nuclear power stations'. Yet all are coastal and therefore vulnerable to storm surges and sea level rise. This would increase the probability of radioactive releases to the biosphere. Moreover, any releases to the sea would be carried worldwide and affect all marine life, including that in the human food chain. Since such a consequence cannot be allowed, nor can nuclear power. Indeed, in the light of climate change – droughts and flooding - and sea level rise, possibly triggering earthquakes or tsunamis, existing nuclear plants on rivers or sea coasts must be phased out and no new nuclear plants built on such sites.

Paragraph 107 says 'The Government believes that the environmental impacts of new nuclear power stations would not be significantly different from other forms of electricity generation...'. Since uranium is depletable, whereas hydro, wind and biomass are renewable, this cannot be true. (See above/below). Moreover, the environmental impacts of nuclear include those of major radioactive releases which differ by very many orders of magnitude from those of all other forms of generation. For example, that from Chernobyl was about 14 ExaBq (i.e. 14 x10^18 Bequerel). (See http://www-pub.iaea.org/MTCD/publications/PDF/Pub1239_web.pdf Page 2).

Paragraph 107 mentions 'generation'. Yet energy savings must be far safer, while also saving any environmental impacts, and are the most cost-effective measures for greenhouse gas (GHG) reduction. (See below).

3) The arrangements for the long-term storage of radioactive waste are still unsatisfactory.

Under 86, nuclear waste can never be 'disposed of', but only put in long-term storage. This should be designed to keep it from the biosphere for ever, but cannot be assumed to do so.

Under 91, the 'solutions' cannot be termed 'robust' since they cannot be proved to be so. Because the consequences are unacceptable, 'reasonably foreseeable' is not good enough.

Under 93, nuclear power is not 'likely to be more cost-effective than alternative forms of low-carbon generation'. Indeed, the opposite has been demonstrated both analytically and empirically. (See below).

Under 94, to say that 'as with all radioactive substances the activity would decline over time' when the half-lives range up to billions of years, is grossly misleading.

Under 95, while 'it could technically be accommodated in the same disposal facilities ... as the existing legacy', no such long-term store yet exists even after more than 50 years.

Under 99, the store can be described as 'interim', but not as 'safe and secure', since this has not been demonstrated. Indeed, since it can only be demonstrated in retrospect, this is wholly misleading.

Under 101, 'not allowing nuclear power to play a role' means not adding to a problem that we have not addressed adequately in over 50 years, yet will threaten the biosphere for ever. Moreover, nuclear power has been shown to be less effective and infinitely less cost-effective than options that pose no comparable ethical implications. (See 9) below).

Since the management of the existing nuclear waste has not been addressed adequately in over 50 years, it should certainly not be added to. Therefore there should be no new nuclear.

4) The nuclear proposal is misrepresented as ethically preferable

Question 10 asks about the ethical considerations related to a decision to allow new nuclear power stations to be built and how should these be balanced against the need to address climate change. Yet the true cost of nuclear power is infinite and it would be the least effective option, contributing no more than one-tenth of the carbon reduction required by 2050. (See 6) below). Hence this is a false dichotomy. Allowing new nuclear would be unethical, since this would preclude options that are hugely safer, faster at carbon reduction and capable of achieving a sustainable energy society. Also, new nuclear would add to the problem of storing radioactive waste, which has not been addressed adequately for 50 years, yet will last for ever.

PERFORMANCE RISKS

5) The nuclear proposal would waste about 14 years before any net carbon reduction

Question 1 mentions '...tackling climate change and ensuring the security of energy supplies are critical challenges for the UK that require significant action in the near term'. Yet the first NPP would be unlikely to start up before 2020. (See Paragraph 25). Moreover, the energy and carbon 'invested' in a NPP over a six year construction period would be huge and the energy may take two years or more to recover. This means it could contribute nothing to reducing net carbon emissions

before 2020. Furthermore, construction delays or initial operating problems would further delay energy recovery, and hence any energy 'profit'. Yet for many electricity end-uses, the stock could be largely or wholly replaced with low-energy equipment within the 14 years from now. Large wind farms can be built in only two years. Moreover, the 'invested' energy is low and is recovered in about half a year. (http://www.vestas.com/NR/rdonlyres/CB1E6A32-EB4E-4845-9451-4B5255BBB111/0/LCA_V9030_20MW_onshore_og_offshore_samt_energibalance_202005.pdf). Hence energy saving options and renewable supply options such as wind farms would reduce the carbon emissions and increase the security of supply over thirteen years sooner.

6) The nuclear proposal would meet no more than one tenth of the 60% carbon reduction required by 2050.

The Energy White Paper 2007 accepts that climate change requires a carbon reduction of 60% by 2050. Yet electricity accounts for only about 30% of the UK carbon emissions, and nuclear power for less than 20% of electricity. Therefore replacing the present nuclear capacity could only reduce carbon emissions by about 6%. Hence to imply that nuclear power is essential – much less sufficient - is wholly misleading. Indeed, Paragraph 20 recognises as much saying that '...it is very likely that the UK will need to take further measures, beyond those set out in the Energy White Paper published alongside this consultation...'.

Paragraph 1.19 says that 'energy companies will need to invest in around 30-35GW of new electricity generating capacity over the next two decades, with around two-thirds needed by 2020'. Yet the first NPP would be unlikely to start up before 2020 and may not be in energy profit before 2022. (See Paragraph 25 and 5) above). Hence, nuclear power can offer nothing towards such a need. Since climate change, fossil fuel depletion and security of supply are pressing, all energy investments should reflect this. As there are many saving and renewable supply options that do so, these should be implemented forthwith, whereupon it would be most sensible to continue with more of the same. This was shown in my quantitative energy study entitled 'Energy Solutions for 60% Carbon Reduction'. The full text, tables, figures and working files are available for download. (http://www.energypolicy.co.uk/epolicy.htm).

7) The supply of nuclear fuel has not been treated with 'due diligence'

Paragraph 110 says that '.. the price of nuclear fuel represents a much smaller part of the cost of electricity than it does for other generating technologies..'. However, the money cost of uranium and it's part in the cost of electricity is irrelevant. What matters is the carbon - strictly the GHG - intensity of uranium, including the effect of depletion, over the planned life of the NPP. The 'point of futility' depends mainly on the available uranium ore grade, and at about 0.01% the carbon intensity of nuclear power exceeds that of gas-fired generation. (See http://www.stormsmith.nl). At the present rate of use, this would be reached in less than 50 years from now – i.e. less than 40 years from 2020. Furthermore, any increased rate of use would shorten this period. (See http://www.energywatchgroup.org/files/Uraniumreport.pdf). This is well understood within the nuclear industry, and occasionally even voiced. (See http://www10.antenna.nl/wise/389/3791.html). Of course, when compared with options having lower carbon intensities, such as energy savings and renewables, the 'point of futility' would be reached at higher uranium ore grades – hence sooner.

Paragraph 111 says that '...the Government believes that there should be sufficient reserves to fuel any new nuclear power stations constructed in the UK'. However, this has not been shown to 'due diligence' standard. 'Believes' and 'should be' is not a sufficient basis for energy policy.

The lifecycle carbon emissions cited fail to take account of the effect of uranium depletion during the lifetime of the NPP. Even at the present rate of use, the carbon emissions would increase over the lifetime of the NPP and may exceed that of gas-fired plant before the end of the lifetime. At any increased rate of uranium use, this effect would be aggravated. On the GHG intensity criterion, uranium may well be insufficient for the planned life of the NPP. Nuclear power is not sustainable, in that uranium may be effectively exhausted soon, whereupon all NPPs will have to be replaced.

Moreover, fossil energy would then be far more costly than today, making the necessary transition to a sustainable energy economy far more difficult. The only prudent 'no regrets' policy would be to deploy energy savings and renewables forthwith – so speeding the necessary transition to a sustainable energy economy. This was illustrated in my presentation 'Energy Criteria for Sustainable Energy Solutions', which may be downloaded.
(http://www.energypolicy.co.uk/sustainpres.htm)

The uranium reserves could be extended by reprocessing. (See Paragraph 12.1). However, this would lead to increased amounts of 'pure' plutonium, which is even more dangerous – as a poison and bomb material - than Uranium 235. In the age of terrorism, this would be foolhardy. Moreover, reprocessing leads to increased 'routine' radioactive emissions to ground, air and water – as shown at Windscale/Sellafield and Dounreay (See
http://www.icsu-scope.org/downloadpubs/scope50/chapter02.html and
http://www.zetnet.co.uk/oigs/n-base/dounreay.htm).

8) The nuclear proposal would be far too vulnerable to events such as a major radioactive release in the UK or overseas.

Any major radioactive release - accidental or deliberate – from the 400-odd NPPs, most of which are very old, would mean nuclear shutdown. Any UK expenditure on NPPs would then become at least a 'stranded asset'. If any NPP had started up, the highly radioactive fuel would make it a 'stranded liability'. If this was before energy payback, there would be no energy profit, but only a loss. In any such event, there would be a catastrophic loss of security of supply. Hence the nuclear proposal would be a hostage to fortune and thus far too risky.

Nuclear power precludes other options because it is so expensive in energy and money, which can be invested only once. Depending on such a fragile and unsustainable option would reduce security of supply, whereas energy savings and renewables such as wind farms, are indigenous, robust and sustainable, and increase security of supply. (See 11) below).

Thus the only rational energy policies are non-nuclear, as chosen by most countries in the world, or nuclear phase-out, as already chosen by Belgium, Germany, Italy, Spain and Sweden. (See
http://en.wikipedia.org/wiki/Nuclear_power).

FINANCIAL RISKS

9) The costs of nuclear have been understated – to an infinite degree.

The cost of nuclear power has been subsidised hugely by R & D funding. This has amounted to $ 1 trillion in Europe alone to date.
(See http://re-access.com/rea/news/story;jsessionid=aWiyO3cA2JI6?id=19012). Moreover, it continues to be allocated mostly to nuclear (See

http://eu.greenpeace.org/downloads/energy/EUsubsidiesReport.pdf p3) – including under the EU Framework 7 programme. (See http://www.essfnetwork.org/documents/FP7 critique final final 16.03.05.doc). Since other energy technology options bring much better returns, this represents a very large opportunity cost and a market distortion. The UK should cease funding nuclear R & D, and require that it cease at EU level, since nuclear power is the least effective and infinitely the least cost-effective. (See below).

The availability under the Euratom treaty of low-cost funds for nuclear power is another market distortion. Moreover, although the fund is limited, when exhausted it is topped up again. (See http://eu.greenpeace.org/downloads/energy/EUsubsidiesReport.pdf p3 and p18). The UK should require that this fund be closed, since it contravenes the European rules on competition.

The costs shown in Figure 4.3 are 'levelised'. That is, they assume current fuel prices for the whole plant lifetime, which for any depletable fuel such as gas, coal or uranium, is grossly misleading. The price must rise as reserves are depleted and if the demand increases. Moreover, a 'point of futility' determined by energy and carbon - as opposed to money - considerations may be reached before the end of the design lifetime of the plant. (See 7) above).

Paragraph 4.29 acknowledges that the cost of electricity shown for nuclear excludes that of the safety risk. Moreover, Paragraph 4.30 says '..we do not consider that the most appropriate approach is to monetise these negative externalities as part of an economic analysis'. No nuclear plants can obtain insurance against all the risks of operation. This suggests that the insurance industry has already made its own risk assessment. Therefore they only operate under special provisions, limiting their liability to levels far below those from the maximum consequences. (See 1) above). The best-known such provision is the Price-Anderson Act of 1957 in the USA, while that in the UK is the Nuclear Installations Act of 1965, including later amendments. Since the insurance industry will not cover it, and so put a finite value on it, the value of the safety risk underwritten by the Government must be taken as infinite. (See http://eu.greenpeace.org/downloads/energy/EUsubsidiesReport.pdf p24). This is expressed as 'unquantifiable' in the Government accounts. (http://www.berr.gov.uk/files/file17806.pdf Section 30.2). As an indication of the value of the safety risk, Chernobyl may have cost over 200 billion roubles, which is said to be four times the estimated total net benefit of Soviet nuclear electricity generation. (See 'The Birth of Europe', by Michael Andrews, ISBN 978-0563360582, 1991, p 272). Any companies seeking to operate NPPs must be required to obtain and themselves pay for full insurance for all risks, both operational and otherwise, with unlimited liability. After all, companies operating other energy supply options do so and anything less would be a gross distortion of the market.

Paragraph 4.29 acknowledges that the cost of nuclear electricity also excludes that of the risk of 'the potential transfer of technology or nuclear material to nuclear weapons production'. Yet the adoption of new nuclear by the UK would make it impossible to deny to any other country, such as Iran. Clearly, the Foreign Office and Ministry of Defence should be asked what value they would place on avoiding this outcome. As a first approximation, it might be taken as the cost to the UK of the war in Iraq. Of course, this has both money and human costs.

Table 4.1 suggests that the cost of radioactive waste storage has been included in the cost of nuclear electricity. Yet this fails to recognise that the storage must be for infinite time, so – regardless of the discount rate – the present value must also be taken as infinite. Not only are the present arrangements inadequate, but those proposed would be ineffective. Paragraph 125 suggests 'ensuring that private sector operators accumulate the funds needed to meet the full costs of

decommissioning and full share of waste management costs'. However, no long term waste storage yet exists, so it cannot be costed with certainty. Moreover, the nuclear operator may go bankrupt, leaving the state to pay. Hence the state must make an estimate of the cost of long term storage and the nuclear operator must pay into a fund managed by the state – as in Sweden.

Since the cited cost of nuclear electricity excludes two infinite subsidies, the true cost in a market free of distortions must be taken as infinite. Moreover, since both subsidies are gross distortions of the market, they must contravene the European rules on competition.

10) The balance of payments and employment implications have not been correctly stated.

Paragraph 112 acknowledges the importance of a supply chain and skills capacity for new power stations of any technology. Yet for new nuclear power, there is hardly any supply chain or sufficient skills in the UK, nor is there any prospect of adding them by 2020. Even if the present Government favoured new nuclear power, it would always be at risk of cancellation – especially in the event of another major radioactive release anywhere. Businesses and individuals would not invest money or careers in such a risky venture. Hence nuclear power hardware and builders would certainly have to be imported, and the UK would be even more dependent upon overseas suppliers. There could be no significant UK exports.

Conversely, for energy savings and renewables, there are many opportunities for businesses and individuals, both in the UK and overseas. A supply chain and skills capacity already exists for wind turbines. Moreover, they would not be at risk of cancellation, since they are not liable to political or catastrophic events. Hence energy savings and renewables would be increasingly indigenous, making the UK less dependent on overseas suppliers. Furthermore, there could be UK exports.

Thus putting further technical and economic resources into nuclear power would have a huge opportunity cost. Indeed, previous subsidised support for nuclear power has contributed directly to the present poor state of U.K. manufacturing. Because it was expensive and dangerous - not least to U.K. security – nuclear power plant could not be exported. Thus the U.K. missed the best opportunities in energy savings, energy efficiency and renewables. Conversely, Denmark rejected nuclear power and is the world leader in district heating and has half the world market for wind turbines.

11) Nuclear power has been wrongly identified as part of a least-cost solution

Footnote 43 mentions a cost-benefit analysis. (http://www.berr.gov.uk/files/file39525.pdf). This is an updated version of the one prepared for the Energy Review 2006 but only nuclear and gas-fired generation were considered. Yet other energy options, notably saving and increased efficiency, have lower costs. (See below). Moreover, the costs assumed for nuclear power are invalid, since they neglect the finite subsidies of R & D funding and the Euratom funds, the effects of uranium depletion, and the infinite subsidies of safety risk and long term waste storage. (See 9) above).

Paragraph 54 cites the IEA World Energy Outlook 2006 in support of the above cost-benefit analysis. However, the WEO 2006 actually said that nuclear energy is the least effective measure for combating greenhouse gas emissions. In the 'Alternative Policy Scenario', the projected reduction of 6 billion tonnes of CO2 equivalent is 65% from improved energy efficiency, 13% from fuel switching, 12% from increased renewables and only 10% from increased nuclear. (See http://www.energywatchgroup.org/files/Uraniumreport.pdf Page 6).

An assessment of the costs of GHG abatement opportunities beyond business as usual was made recently by Vattenfall. (See http://www.vattenfall.com/www/ccc/ccc/569512nextx/573859globa/574118cost/index.jsp?origin=search). This showed that 5 billion tonnes of CO2e could be saved at negative cost. Like most others, this study understates the cost of nuclear power. (See 9) above). Since there are two infinite subsidies, the true cost of nuclear is infinite. However, the data for other options is not affected.

Conclusions

It would not be in the public interest to give energy companies the option of investing in new nuclear power stations. This is the least effective and least cost-effective option for tackling climate change and thus reduces energy security. Moreover, it would increase the safety risks to people and property in the UK and overseas and the 'unquantifiable' financial risk to the public purse. Furthermore, nuclear power is not sustainable, so it would delay the necessary transition to a sustainable energy economy, making this much more difficult.

Nothing should be done to facilitate nuclear power. However, the Government should consider comparable facilitative actions for energy savings (such as large-scale district heating from CHP and industrial 'waste' heat) and renewables (such as municipal waste, biomass and wind turbines, both onshore and offshore). Unlike nuclear power, these are sustainable, and would contribute to the necessary transition to a sustainable energy economy.

This nuclear consultation document is irresponsibly incomplete on the various risks – safety, performance and financial. However, my evidence shows that for meeting the long-term climate change and energy security goals, new nuclear power would be by far the least safe, the least effective and by far (infinitely) the least cost-effective option. The Government has failed adequately to consider other energy options and to look ahead to a sustainable energy economy.

Gordon Taylor, B.Sc., M.Sc., M.I.Mech.E.
G T Systems
19 The Vale, Stock, Ingatestone, Essex, CM4 9PW
Tel: 01277-840569
Email: gordon@energypolicy.co.uk
Web: http://www.energypolicy.co.uk