GREENPEACE

Part 1 of submission of evidence to:

House of Commons Environmental Audit Committee Inquiry:
Keeping the Lights On: Nuclear Power, Renewables and Climate Change

NUCLEAR

24 How do the waste and decommissioning costs of nuclear new build relate to the costs of dealing with the current nuclear waste legacy?
NDA – scale of current liabilities; Nuclear Wastes from new build.

26-29 Spent fuel: – a case in point in problems of determining the current *and* future costs.
Spent fuel costs; THORP shutdown – more problems? Plant life extension; Massive increase in spent fuel holdings under new build; How much additional radioactivity from new build? Disposal or storage of spent fuel?
29-32 How confident can we be that the nuclear industry would invest adequately in funds ring-fenced for future waste disposal?
Background and current situation British Energy; NDA & BNFL – state aid investigation – another example of bad prediction; Ring fenced funds?

33-34 CO_2 emissions and nuclear power

34 Security of supply

35-37 New Build: Proliferation, terrorism *and* security?

35-36 Proliferation

36-37 Terrorism

38-40 CO2 emissions and the nuclear chain

38 Uranium and CO_2

38-39 Uranium – decreased supply, lower grades, more CO2 emissions

39 Proliferation implications from plutonium use if uranium is scarce

39-40 Uranium mining and waste

41-45 Nuclear Waste – Public Concern and Mistrust

Introduction

42-43 Public mistrust of industry plans

43-45 Examples of opinion polls:

- *Eurobarometer latest on public views on nuclear power and nuclear waste:*
- *Only 1 in 4 support new nuclear reactors in the UK*
- *Poll shows nuclear waste as key environmental issue for the public*
- *The establishment of the Nuclear Decommissioning Authority (NDA) on 1st April 2005 has had little impact on public awareness.*
- *73% of Scots support building more wind farms and only 17% the nuclear option. More than half of UK public opposed to new nuclear stations*
- *59% say it would be irresponsible to build more nuclear power stations while problems remain in disposing of nuclear waste.*

46-48 APPENDIX 1 Segregated Decommissioning Funds

49-56 Attachment with reference to TOR 4.2 of the Environmental Audit Committee:
Articles on the spread of civil nuclear power and proliferation issues

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Summary

1. There are significant uncertainties over construction and costs and timelines which are influenced by many variable and interdependent factors, such as the extent of government subsidies, licensing processes and planning inquiries. It is most likely a new reactor would not be operating in the UK until 2018-2020 – and that's if the go-ahead is given next year.

2. Even if the Government gives in-principle agreement to new build, it would not necessarily mean private investors would be willing to fund the enterprise. Uncertainty over costs is a significant factor in private sector reluctance to invest in new build. It is highly unlikely that the financial sector would provide capital for new build unless construction costs and liabilities are extensively underwritten by the firm guarantees of public finance. Government subsidies of the order needed to kick start new build, and provide for liabilities, would not be compatible with liberalised energy markets. Moves by the Government to finance new build would be challenged under European Competition law.

3. The amount of time taken to build reactors impacts on the time it takes to realise a return on capital. Companies will put investor and shareholder expectations on returns and dividends before properly financing segregated funds for liabilities.

4. Due to the lack of legally binding requirements for segregated funds there is absolutely no obligation on the industry to adequately invest in ring-fenced funds for waste and decommissioning costs for nuclear new build - unless segregated funds are made a legal requirement. Because of this, the risk to the public purse of having to bailout future private nuclear operators for liabilities is significant.

5. The amount of Government financial support that would be required to facilitate private sector investment in nuclear new build would be massive. It would be a major gamble with public money on a large, centralised energy system which may not provide returns on the investment – and which could rapidly become a liability through accidents or technical failures.

6. Nuclear programmes take a huge amount of money and resources. There is only so much money the Government has to spend and if it opts for new build it is likely, based on past experience, that cleaner, safer energy systems will lose out. There are however significant risks that a series of ten reactors, of an untried and untested design, will not work to expectations. That would mean many years of opportunity to implement workable and clean renewable technologies and energy savings measures instead of nuclear power would be lost. Greenpeace believes that investing a nuclear programme which has many risks attached to it would actually undermine security of supply – not enhance it.

7. Estimates for new build, drawn from actual costs of past reactor projects indicate prices will be far higher than the industry's figures for new reactors. The costs for

waste (including decommissioning, clean-up, storage and disposal) for new build are not quantifiable. Estimates remain estimates.

8. Indeed, the cost for decommissioning and clean-up of existing sites is rising, with no final figure available for long term management or disposal of all wastes. New build will only exacerbate the problem of nuclear waste in the UK. The amount of the most long-lived and hazardous nuclear material produced by nuclear reactors, spent nuclear fuel, will increase 400% under a new build programme.

9. Insurance back-up by the Government is also 'unquantifiable'. Financial compensation arrangements following a major accident or terrorist attack on a nuclear installation would have to stretch decades into the future and no reasonable estimates can be given for the financial costs of such an eventuality. Little is known about the full scope of security measures and cost associated with the nuclear industry.

10. A new build programme in the UK, if in place between 2020-2030, would only offset CO_2 emissions by about 4-5% (based on an estimate of the energy mix at the time). A new build programme is not a timely response to the immediate need to act on implementing the energy systems required to reduce CO_2 emissions well before a new build programme would 'take effect' i.e. 2025-2030. Unless there is a huge expansion in nuclear power, it will have little or no impact on the Government's targets for CO_2 reductions beyond 2020.

11. Embarking on a new build programme in the UK would send a signal across the globe that nuclear power is an appropriate response to tackling climate change. Yet the majority of materials and technology used in nuclear power programmes are dual-use – that is they can be used in civil *and* military programmes. Quite simply, spreading nuclear power spreads the wherewithal for nuclear weapons proliferation.

12. A global increase in the use of weapons usable nuclear materials would serve to further increase the chances of these materials falling into the hands of terrorists. More nuclear reactors here and the attendant spent fuel stores, means more terrorist targets – which could, over time, increase the likelihood of a successful attack on such an installation.

13. Nuclear power is not a major source of CO_2 emissions, but the nuclear fuel chain does give rise to CO_2 emissions. Studies have shown that overall the use of nuclear power produces more CO_2 emissions than renewable energy sources such as wind. The CO_2 emissions associated with nuclear power will increase as companies are forced to use lower grade uranium ores as more accessible, higher-grade uranium reserves are used up.

14. Nuclear new build is conditional on the development of acceptable solutions to the problems of managing nuclear waste. Greenpeace believes there is no 'solution' to the nuclear waste problem – only 'least worst' options. The public will be even more determined in its opposition to new build once it realises the extent of the additional nuclear wastes which will be produced by this form of electricity generation.

Recommendation:

15. For all of these reasons, Greenpeace asks that the Committee recommend against any new build programme.

Construction Costs, Operating Costs and Timelines

TOR 2.1
What are the likely construction and on-going operating costs of different large-scale technologies (e.g. nuclear new build, CCGT, clean coal, on-shore wind, off-shore wind, wave and tidal) in terms of the total investment required and in terms of the likely costs of generation (p/kWh)? Over what timescale could they become operational?[1]

Construction costs – not a stand alone matter

'The key issue with new nuclear's valuation: It depends on many (and fairly volatile) assumptions.'
Building a new nuclear plant is largely a 60-year bet on interest rates – think of a number....'
UBS Investment Research: - Q-Series, The Future of Nuclear, March 2005

16. There are complex links between the construction costs and the time it takes to build a reactor, licensing arrangements, security and terrorism, the politics of waste disposal, the willingness of Government to subsidise or support front or back end costs and the willingness – or otherwise – of financial institutions or utilities to support new build.

17. Pay-back time on capital and the size of dividends have to be set against the need to ensure that sufficient liability funds are set aside - and at the right time - to safeguard against the taxpayer having to fund liabilities.

18. In determining costs it is not possible to separate out the industry's hopes regarding Government assistance (e.g. low interest loans) and come up with purely theoretical costs as these issues are so interdependent.

19. At present there is very much a stand off situation, where the Government has indicated it is not willing to move new build forward unless the industry, financial institutions and utilities express a real interest in new reactors. Government, investors and industry are all cautious because of the level of public opposition to new build and/or waste disposal plans (see page 38-41 for discussion on the publics' views on new build and nuclear waste).

20. Because of the linkages outlined above, Greenpeace cannot respond to the Terms of Reference in the order as set out by the Committee but will instead respond in the order which best explains the issues from the organisation's perspective.

Problems with establishing construction costs for new nuclear power stations: The AP1000 - an example.

21. A number of the reactor designs proposed for new build programmes have not yet been built. In the main they are modified designs of existing reactor types and some have had significant design modifications made primarily for cost savings. The Westinghouse AP 1000 began life as the AP 600 (a 600 MW reactor as opposed to the 1000 MW – 1GW -that is now being proposed).

[1] Greenpeace will respond on the issues concerning non-nuclear energy and energy demand in a separate section of this submission.

22. However, after getting a licence agreement to build the AP 600 Westinghouse found that utilities were not interested, primarily because of the cost. Therefore, Westinghouse increased the power output by 80% with apparently only a 20% increase in construction costs. As both designs only exist on paper the economics are purely theoretical.

23. Any reactor proposed design will also have to undergo licensing to allow it to be built and operated in the UK (see pages 10-12 for discussion on licensing issues).

24. Because industry costings are theoretical, it is not possible to provide firm figures for construction, operation *and* decommissioning costs for the reactors 'on offer'.

25. Some figures for construction alone are in the public domain. Reports have given costs of US$2.2-2.7 billion for two reactors of 1GW,[2] with others quoting Westinghouse as having given a figure of US$1.5bn per 1GW reactor.[3] This would mean construction costs at approximately £0.6bn-£0.8bn per reactor. More recently, in comments made during a presentation to the International Nuclear Congress this year, BNFL's Richard Mayson said a 1GW AP1000 reactor would cost £1.3bn[4] but with reductions over a series of reactors.

26. The US Congressional Budget Office (CBO) has said it believes the industry's projected costs for reactors of approximately 1GW, to be overly optimistic and estimates that construction costs would most likely be much higher than industry estimates at between US$2.1bn-$3bn (£1.16bn-£1.66.bn) each. It uses US$2.5billion (£1.38bn) as a working figure.[5] The CBO also says that it believes the risk of default on Government loans towards capital for these 'first of a kind' reactors is so high that the US Government should not make such loans available. In its paper in June 2005, Oxera gives an estimate of £1.6bn for the first reactor (including development costs), reducing to £1.15bn for subsequent reactors.

27. Ten reactors: BNFL/Westinghouse claims that costs will fall over a ten reactor programme and by the time of construction of the fifth reactor, the cost would be significantly less than for the first.[6]

28. Using the figure £1.3bn given by BNFL, and CBO's figures (but allowing for the possible cost reductions claimed by the nuclear industry) the costs could be £9.8bn-£12.6bn for 10 1GW plants. [7]

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[2] *Westinghouse expects to receive NRC certification for its AP1000* Platts Nuclear News Flashes 3rd September 2004. It is assumed these are purely construction costs.
[3] The International Herald Tribune, (2/9/04)'*China looks abroad for nuclear help*'
[4] *Fuel for Thought* conference, British Nuclear Energy Society, Newport Wales, 6-7 July 2004
[5] Congressional Budget Office Cost Estimate May 7, 2003 S. 14 Energy Policy Act of 2003 as introduced on April 30, 2003 The CBO puts the cost of the first reactor at US$2.1-£3billion. http://www.cbo.gov/showdoc.cfm?index=4206&sequence=0
[6] BNFL/Westinghouse *AP1000…the reactor technology ready now*. Presented to the Energy Review in 2002.
[7] In BNFL/Westinghouse's claims the initial cost will include regulatory costs associated with licensing and associated site engineering works and financing costs. It is not clear if the costs of the subsequent reactors includes these costs. Richard Mayson did not explain exactly what costs would be included in the £1.3bn figure, but it is assumed that licensing would be part of the cost. Based on BNFL/Westinghouse claim costs for reactors reduce to 86% for the 2nd plant, 78% for the 3rd, 77% for the 4th and 69% for the 5th-10th.

29. If however there are no cost savings ten new reactors could cost £13bn (BNFL) or £16.7bn (CBO's highest figure).[8] Cost reductions for programmes undertaken overseas certainly cannot be taken as a given for what might happen in the UK due to the different regulatory and inquiry processes (BNFL/Westinghouse based their costs reductions on a reactor programme in South Korea). Changes in exchanges rates markedly influence prices (as either a positive or a negative for the buyer or seller) if components are being bought from overseas.

30. It is this level of uncertainty which makes the market very wary of investing in nuclear power.

Ten plants *have* to be built – a massive upfront investment

31. In order to achieve lower costs across a new build programme, to get nuclear costs on a par with the costs of wind energy, a commitment would have to be given to build ten plants. Economy of scale is absolutely essential for the industry to keep its costs low. [9]

32. A ten-reactor programme would entail a massive upfront commitment from industry, the Government/taxpayer and electricity consumers for an untried and untested reactor design. It would probably also entail having a number of sites 'lined up' and ready to accept new build – delays for inquiries at each site would significantly risk increasing costs. To set up a series of sites to host the reactors would probably mean major – and unwelcome changes – to planning inquiry processes. In addition, the industry needs a workforce which is capable of building and operating ten plants. This may not be not available over the 60 years of planned life of the reactors.

Financing New Build – analysis of reports

TOR 3.1
What is the attitude of financial institutions to the risks involved in nuclear new build and the scale of the investment required? How does this compare with attitudes towards investment in CCGT and renewables?[10]

'*One rule of thumb is to double the stated costs of nuclear stations to arrive at the genuine figure, and this reflects the broad experience in the UK'*

i. Simon Skilling, Head of Regulation, EON UK, June 2005, London[11]

33. There have been a number of reports concerning the financing of new nuclear reactor build in recent years as debate on new build has increased in the UK and the US.

[8] Also important to note is that these figures are based on an average exchange rate of US£1.80 = £1.
[9] Whilst the Committee has said 'nuclear new build' is used to refer to a programme of building at least eight AP1000 reactors (or equivalent) this submission is based on a new build programme of 10 1GW plants, based on industry proposals. Others – including CoRWM in assessing the radioactive waste impact of new build - have also assumed a 10 reactor programme.
[10] Discussion on the cost of renewables and CCGT is dealt with in Part 2 of Greenpeace's submission.
[11] http://www.westminsterenergy.org/events_archive/downloads/june24/WEF_Nuclear_Investment_Policy_Issues_Exec_Summary.pdf

34. All have pointed towards the same problems and risks to a greater or lesser degree that will deter investment in new nuclear: They also all conclude that some form of State support in the form of grants, loan guarantees etc would probably be required if new nuclear power plants are to be built. Other factors that could jumpstart a nuclear renaissance, by making it more financially attractive, are reducing the cost of construction and the time required, which may involve regulatory changes.

35. Some of the studies of the economics of nuclear power over the past 3-4 years include:

Canadian Energy Research Institute[12]
University of Chicago[13]
International Energy Agency/Nuclear Energy Agency[14]
Lappeenranta University of Technology[15]
OXERA[16]
MIT[17]
Performance and Innovation Unit[18]
The Royal Academy of Engineering[19]
USB[20]

36. The table on Page 9 summarises the major conclusions of these studies. Although there is some variation between the economic assessments of the different studies what is more notable is the difference between the paper studies and the *actual* data provided by the construction of Sizewell B. The actual construction costs are more than double any of the forecasts put forward in these analyses. Furthermore, the length of construction at 86 months is longer than any single figure put forward while the capacity factor of Sizewell is considerably lower than the forecasts put forward.

37. The Sizewell B figures, although far higher than recent forecasts are not an exception. Analysis of the costs of constructing the Advanced Boiling Water Reactor in Japan gives similar delays and costs over-runs. General Electric estimated that its 1300 MW Advanced Boiling Water Reactor could be constructed in 48 months and at a cost of $1,528 per kilowatt. However, when finally built in Japan for the Tokyo Electric Power Company, it had taken approximately 60 months to build and the first unit cost $3,236 per kW, the second $2800 per kW[21] (these equate to £2006/kW and £1736/kW at 1997 conversion rates).

In addition to the financial issues the reports referred to, the reports also highlighted other problems for new build, namely:

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[12] Canadian Energy Research Institute, August 2004, *Levelised Unit Electricity Cost Comparison. Ontario*
[13] University of Chicago, August 2004, *The Economic Future of Nuclear Power*
[14] OECD/ IEA NEA 2005, *Projected Costs of Generating Electricity*- update, 2005
[15] *Nuclear Power: Least- Cost Option for Baseload Electricity in Finland* RistoTarjanne & Sauli Rissanen, Uranium Institute, 2000.
[16] *Financing the nuclear option: modelling the costs of new build*, Oxera Agenda, August 2005
[17] *"The Future of Nuclear Power: An Interdisciplinary MIT study*" available at http://www.mit.edu/afs/athena/org/n/nuclearpower/
[18] The Energy Review, Performance and Innovation Unit, February 2002
[19] Royal Academy of Engineering 2004, *The costs of generating electricity*
[20] *"More a question of politics than economics"*, Q Series: The Future of Nuclear, UBS Investment Research, March 2005
[21] Congressional Research Service, CRS Report for Congress. *Nuclear Power: Prospects of New Commercial Reactors* 27 July 2001

- what to do with the nuclear waste created;
- the costs of decommissioning; and
- issues of health, safety and the environment.

38. Significant attention must be placed on the financing mechanisms, and not just costs estimates, considering the economics. A report prepared for the US Congressional Budget Office (CBO) looked at the proposals for legislation on federal loans to support new build in the US. [22]

39. The proposals for Loan Guarantees for Nuclear Power Plants Energy Law (S. 14) would have authorised the US Department of Energy (DOE) to provide loan guarantees for up to 50 percent of the construction costs of new nuclear power plants and would have authorised the DOE to enter into long-term contracts for the purchase of power from those plants.

40. The report notes that no new nuclear plants have been ordered in the U.S. in the last 25 years, and the last was completed in 1996. Based on information from the DOE about preliminary construction plans at three sites, the CBO stated it expected the department would provide credit assistance for six nuclear power plants over the next 20 years. The comments – provided below in full – show that the CBO thinks:
    - the risk of default by the owners of the reactors would be greater than 50% - and therefore should not go ahead;
    - that even if the reactor is completed and monies recovered through electricity sales, the overall subsidy cost would be 30% of the project; and
    - that taking a long-term purchase agreement would be even more expensive than a construction subsidy.

41. CBO text:

Estimates of the cost for such a plant range from $2.1 billion to almost $3 billion, including engineering, procurement, and construction, as well as costs associated with construction delays, and first-of-a-kind engineering costs.

42. "For this estimate, CBO assumes that the first nuclear plant built using a federal loan guarantee would have a capacity of 1,100 megawatts and have associated project costs of $2.5 billion. We expect that such a plant would be located at the site of an existing nuclear plant and would employ a reactor design certified by the NRC prior to construction. This plant would be the first to be licensed under the NRC's new licensing procedures, which have been extensively revised over the past decade.

43. Based on current industry practices, CBO expects that any new nuclear construction project would be financed with 50 percent equity and 50 percent debt. The high equity participation reflects the current practice of purchasing energy assets using high equity stakes, 100 percent in some cases, used by companies likely to undertake a new nuclear construction project. Thus, we assume that the government loan guarantee would cover half the construction cost of a new plant, or $1.25 billion in 2011. CBO considers the risk of default on such a loan guarantee to

[22] March 2003 – Congressional Budget Office (CBO) Cost Estimate May 7, 2003 S. 14 Energy Policy Act of 2003 As introduced on April 30, 2003

be very high--well above 50 percent. The key factor accounting for this risk is that we expect that the plant would be uneconomic to operate because of its high construction costs, relative to other electricity generation sources. In addition, this project would have significant technical risk because it would be the first of a new generation of nuclear plants, as well as project delay and interruption risk due to licensing and regulatory proceedings.

44. *In its 2003 Annual Energy Outlook, the Energy Information Administration (EIA) projects that production from new nuclear power plants would not be cost-competitive with other power sources until after 2025. EIA also reports that current construction costs for a typical electricity plant range from $536 per kilowatt of capacity for natural-gas-powered combined-cycle technology to $1,367 per kilowatt of capacity for coal-steam technology. Although construction costs could diminish significantly as a new generation of nuclear plants are built, a new nuclear power plant starting construction in 2011 would have a construction cost of about $2,300 per kilowatt of capacity. By 2011, that cost would result in capital costs that are 40 percent to 250 percent above the cost of capital for electricity plants using gas and coal. Because the cost of power from the first of the next generation of new nuclear power plants would likely be significantly above prevailing market rates, we would expect that the plant operators would default on the borrowing that financed its capital costs.*

45. *Assuming the nuclear plant is completed, we expect it would financially default soon after beginning operations, however, we expect that the plant would continue to operate and sell power at competitive market rates. Thus, over the plant's expected operating lifetime, its creditors (which could be the federal government) could expect to recover a significant portion of the plant's construction loan. The ability to recover a significant portion of the value of the initial construction loan would offset the high subsidy cost of a federal loan guarantee. Under the Federal Credit Reform Act, funds must be appropriated in advance to cover the subsidy cost of such loan guarantees, measured on a present-value basis. CBO estimates that the net present value of amounts recovered by the government on its loan guarantee from continued plant operations following a default and the project's technical and regulatory risk would result in a subsidy cost of 30 percent or about $375 million over the 2011-2013 period. Based on information from DOE, we expect other loan guarantees would not be issued for nuclear power plants until after 2013.*

46. *Alternatively, under the bill, DOE could choose to forgo the loan guarantee and enter into a long-term purchase agreement to buy some or all of a nuclear plant's production instead. Under this option, the full value of funds committed by the government to purchase power from a nuclear plant over many years would need to be appropriated in advance, prior to construction, to assure a private lender that future cash flows would be adequate to cover debt-service costs. CBO estimates that this option for financial assistance would cost more than a federal loan guarantee and that DOE would probably not use this alternative.*

Comparison of assumptions in recent forecasts of generation costs from nuclear power plants[23]

Forecast	Construction cost (£/kW)	Construction time (months)	Cost of capital (% real)	Load factor (%)	Non-fuel O&M (p/kWh)	Fuel cost (p/kWh)	Operating life (years)	Decommissioning scheme	Generating cost (p/kWh)
Sizewell B	2250 3000	86	-	84	1.15	0.7	40	Part segregated, part cash flow	-
Lappeenranta Univ	~1300		5	91	0.5	0.2	60		1.6
Performance & Innovation Unit	<840	-	8 8 15	>80			30 15 15		2.31 2.83 3.79
Massachusetts Institute of Technology	1111	60	11.5	85 75	0.83	-	40 25		3.7 4.4
Royal Academy of Engineers	1150	60	7.5	90	0.45	0.4	40	Included in construction cost	2.3
Chicago University	555 833 1000	84	12.5	85	0.56	0.3	40	£195m	2.9 3.4 3.9
Canadian Nuclear Ass	1067	72	10	90	0.49	0.25	30	Fund. 0.03p/kWh	3.3
IEA/NEA	1100-2500	60-120	5 10	85	0.38-0.90	0.15-0.65	40	Included in construction cost	1.2-2.7 1.8-3.8
OXERA	1625 first plant 1150 later unit			95	0.35	0.3	40	£500m in fund after 40 years life	

Notes:

1. Sizewell B operating costs are the average for all eight of British Energy's plants including seven AGRs as well as the Sizewell B PWR.
2. The MIT O&M cost includes fuel.

[23] Table taken from "*The Economics of Nuclear Power – Analysis of Recent Studies*, by Steve Thomas, Public Sector International Research Unit, Greenwich University, July 2005, Funded by The Environment Agency.

Licensing/Timeline for new build

47. To install a total of 10 1000MWes units at a rate to replace closure of most of the largest Advanced Gas-cooled Reactors (AGR) would require a new build programme to be complete by 2025 - and entail installing new capacity at an average of 770MWe/year from 2010 or commissioning onto the grid a new AP1000 nuclear reactor every one and a half years from 2010 until 2025; an extremely ambitious target given the nuclear industry's past construction record.

48. As part of its case for more reactors, the nuclear industry provided estimates for construction time for new build to the Government's energy review in 2002. BNFL/Westinghouse claimed each new reactor would take 33-40 months to construct - an optimistic estimate compared with the 86 months it took to construct the UK's last nuclear reactor Sizewell B. As can be seen from the reports chart on page 9, most other commentators believe new plants would take longer than the BNFL/Westinghouse time for construction.

49. Most independent industry analysts acknowledge that the first reactor of any new build programme probably wouldn't come on line until 2018-2020.[24] The points below give an indication of what a timeline for new build might look like and what processes would have to be gone through:

50. An Energy Review takes place - in 2006? If that review gave the policy green-light to new build it would be substantially earlier than the 'promised' five years for renewables to be allowed to be developed – it might therefore be challenged by companies investing in major renewable projects

51. Late 2006 - 2007 - If nuclear power is given the go-ahead as part of a future energy mix under an Energy Review this will then be followed by consultation on a White Paper on new build (unless the Government combined the Energy Review and White Paper process).

52. If nuclear was still given the go-ahead, all designs proposed for construction in the UK would have to be licensed by the Nuclear Installations Inspectorate (NII). All reactors are untested in the UK and would be subject to lengthy licensing processes before a licence could be granted. It is expected this process could take five years. The NII is significantly understaffed and may not have the available staff to oversee this process.

53. Many significant question marks hang over how the NII will deal with licensing a new reactor design for the UK.
54. Will it accept a reactor that has been licensed overseas - with minimal input from the Inspectorate to ensure it meets UK regulations?

55. Will it accept a 'one size' fits all licence across all sites once a reactor has met the UK licensing conditions e.g. if a reactor is ok to be build at Hinkley, then it can be

[24] *Nuclear Power and the Characteristics of 'Ordinariness'* – the case of UK energy policy', Gordon MacKerron, NERA Economic Consultants, September 2004

built anywhere on existing sites because they already have reactors and are 'fit' sites for nuclear power plants?

56. Will there be proposals to really streamline the inquiry process e.g. one inquiry into one reactor design which then fits all sites? How will the NII and other regulators deal with multiple reactor design licensing and tendering?

57. If the Government does give the green light to new build, will several companies then have to tender to build different designs which then go through the licensing process? This would add to the uncertainty of the final cost of the design chosen, and raises the possibility of the NII refusing to award a license.

58. Alternately, will all those wishing to build in the UK have to put their designs through the NII licensing process before tendering? This could lead to a huge unmanageable work load at the NII.

59. All tenders to build would probably be subject to competition under EC regulations to ensure there are no illegal state aid subsidies attached to the tenders.

60. In the US the Nuclear Regulatory Commission has indicated it is not willing to go through the full licensing unless companies had a firm intent to build and to show that they had to have a domestic utility interested in the design.[25] Will up-front investor and/or utility interest in new build in the UK form part of the NII's process for how it deals with licensing?

61. Also, who pays for licensing? Can the NII cope with all of this at the same time as overseeing a massive decommissioning programme – at a time when it has not got enough staff (or just enough) for current inspections/oversight? Who will pay for extra staff for the regulatory process to oversee reactor design licensing and planning inquiries? Will the taxpayer be expected to cover this?

62. Depending on the reactor design approved, additional time, possibly 2-3 years, might still have to be spent on siting and planning issues. Attempts to circumvent inquiry processes, through curtailing local government input or removing the ability of the public to challenge certain aspects, will probably face legal challenges themselves.

63. Around the same time as the licensing process for reactors might begin, the renewed search for a national nuclear waste dump could get underway following CoRWM's recommendations to the Government on long term options on radioactive waste management. This will undoubtedly focus public attention on where waste is coming from.

64. Construction could take 3 years (best case industry estimates) or 5-7 years (independent commentators/experience-based construction times). Depending on events both at UK overseas reactors there could be legal challenges or regulatory changes during construction – the industry is keen to change legislation to prevent this happening.

[25] *AP1000 certification rulemaking entering public comment phase*, Nucleonics Week, 17th March 2005

Licensing – AP1000

65. Industry plans for multi-reactor programmes – based on exactly the same design – does nothing to assuage concerns over safety. As experience in Japan and France has shown such programmes raise the risk of generic faults in each reactor disabling all the plants. There is particular concern over the AP1000 as it has significantly less safety features than the currently operating reactors.

66. Safety and costs are inextricably linked and none more so than in the case of the untried and untested AP1000 design – an attempt at cost cutting which omits safety features which are regarded by the NII as essential for a PWR. Here is the background to that design:

67. The last time that the British nuclear industry applied for a license for a PWR was in 1981. The Westinghouse SNUPPS design, (a generation II reactor) which already had several years operating experience, was submitted for construction at Sizewell.

68. Design changes required by the NII in order for that design to meet British safety standards resulted in Sizewell B having 13% more large pipework and 22% more cabling than SNUPPS (as well as 75% more structural concrete).[26] The last surviving US order for a Westinghouse reactor was made over 30 years ago. In the US the Westinghouse AP600 design dating from the mid 1980's has been licensed but no-one has invested in it, so it has never been put to the test.

69. The AP1000 increases output from the same reactor pressure vessel by packing it with more fuel and pumping through more water, thus defeating the lower power density safety principles of the AP600.

70. The AP1000 'simplification' involved stripping 50% of the valves, 83% of the pipes, 87% of the control cables, and 35% of the pumps from a similar sized PWR. Richard Mayson of BNFL has stated:[27]

71. *"In broad terms, it's roughly half the concrete and steel and therefore it doesn't take a genius to work out that's roughly half the capital cost of what Sizewell should have cost."*

72. There are doubts the AP1000 can fulfil British safety standards with far less pipework and cabling than the original SNUPPS design . The public and Parliament will be understandably wary about the cost-cutting motives behind the 'simplification' of PWR designs (such as the AP1000) while prospective investors are unlikely to be impressed by design innovation that does nothing, of itself, to prevent accidents that - in a very short time - could convert a huge investment into a huge liability.

73. It is also important to remember that the AGRs now operating in the UK (a number of which are experiencing shutdowns because of technical problems) were heralded

[26] Sizewell B Inquiry, CEGB proof 8 App 5, Fig 6
[27] Speaking at an Institute of Physics Symposium as quoted in Nucleonics Week/Volume 45/ Number 19 / May 6, 2004

by the industry as cutting-edge technology. Many of the same organisations that promoted those reactors are the same as those promoting today's designs.

Operational issues

"The abiding lesson that TMI taught Wall Street was that a group of NRC-licensed reactor operators, as good as any others, could turn a $2 billion asset into a $1billion clean up in about 20 minutes"

Peter Bradford, former member US NRC
(quoted New York Times, 4/5/2005)

74. As reactors get older, age related problems occur - resulting in lower safety margins. In a number of cases the problems have been compounded by lack of sufficient regulatory oversight. As we know from the problems BE is experiencing at a number of its reactors, economic pressures have led to reduced safety and maintenance, which in turn have led to unplanned outages. Reduced employment levels also impact on plant safety and operations.

75. The plans by BNFL/Westinghouse are to have reactors operate for 60 years; other companies propose an operating life of 40 years.[28] This has implications not only because of what is known about the problems of ageing in reactors, but it also has cost implications for investors waiting to see capital refunds and dividend payments. Operational life is also a crucial factor in deciding when decommissioning funds should start to be put aside (for Greenpeace's view on this Appendix 1 and discussion on page 42).

76. The life time of a reactor also has a significant impact in terms of the amount of highly radioactive spent nuclear fuel produced – which also has to be provided for (and stored somewhere). This is discussed further on pages 24-28.

77. As part of this submission, Greenpeace has attached a major report undertaken on the hazards of different reactors and technical problems associated with them. The report *Nuclear reactor Hazards- Ongoing Dangers of Operating Nuclear Technology in the 21st Century*, published on 25th April 2005, explains the many problems which exist with today's reactors and which could well occur in the next generation of reactors.[29] Greenpeace hopes it will help the Committee in appreciating the scale of the problem of current designs and what problems might arise in the future.

78. Greenpeace is not alone in its concerns. At the recent International Nuclear Congress, the Chief Inspector of the NII told an industry audience that sustained excellence is needed for industry operations. As his presentation showed however, the industry was only achieving an average performance.[30] It is important to note that the NII is itself understaffed.[31] Significant resources would have to be put in

[28] For information on industry plans for 60 year life for reactors see – CORWM: http://www.corwm.org.uk/PDF/1277%20-%20Task%20088%20Study%20Report%20Final%20Draft.pdf
[29] Greenpeace International Reactor Hazards Report http://www.greenpeace.org/international/press/reports/nuclearreactorhazards
[30] NII presentation to International Nuclear Congress http://www.fuelforthought.org.uk/MikeWeightman.ppt
[31] *National nuclear inspectorate short of staff*, Sunday Herald 6/2/05

place to increase and extend staffing at the inspectorate to deal with a new build programme.

79. In recent years the World Association of Nuclear Operators (WANO) has publicly stated it has major concerns over safety standards. In a speech in 2003, WANO's listed of a number of “severe incidents” that have occurred over the past few years. These include:

- reactor pressure vessel head seal leakage at Sizewell-B
- incorrect boron concentration at Philippsburg
- Unprecedented fuel damage at Cattenom
- A pipe break in reactor head spray system at Brunsbuettel
- reactor pressure vessel head corrosion at Davis-Besse
- extensive ex-core fuel damage at Paks
- data falsification at both Sellafield and Tepco.[32]

80. Some of these accidents have had massive financial impacts. The closure of the Davis-Besse plant in 2003 cost the owner $298-million for replacement power, operation & maintenance, and capital in 2002, and as of August 2003, replacement power and O&M costs for the year totalled $205-million.[33]

81. It is because of the problems experienced with current reactors, potential problems with ‘new’ designs, construction costs, liability funding (see pages 28-30 and Appendix 1) and potential licensing delays, the industry has lobbied Governments to either change licensing (and siting processes) and provide financial assistance for construction and liabilities.

82. This submission could not go acknowledging the massive health, social and financial costs of the Chernobyl disaster. The impacts of that reactor accident are still being felt today – and indeed will be for many generations to come. Greenpeace has not gone into the financial impacts – or devastating health and social impacts of the Chernobyl disaster in this submission. However, some of the impacts of Chernobyl are discussed in the attached report from Greenpeace International.

83. This leads to discussion of TOR 3.2 on the likelihood of Government subsidy.

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http://www.sundayherald.com/47583

[32] Nucleonics Week— Volume 44 / Issue 42, October 16, 2003] Complacency, negligence threaten nuclear industry, WANO warns

[33] ibid

Support Mechanisms – Financial and legal

TOR 3.2:
How much Government financial support would be required to facilitate private sector investment in nuclear new build? How would such support be provided? How compatible is such support with liberalised energy markets?

Differing views:

"I am pretty confident that if we have future nuclear reactors in the UK there'll be no question of subsidies"
Steve Kidd, World Nuclear Association, Open University Seminar, *Nuclear or Not,* 15th March 2005

'Oxera's modelling analysis shows that the nuclear option is by no means closed, although economic investment is likely to require government support'
Oxera, *Financing the nuclear option: modelling the costs of new build* June 2005

84. In a number of seminars the industry has said it believes the Government should provide support for new build, although some industry commentators have claimed that no such support is necessary. Certainly the level and extent of support expected by the industry is not compatible with liberalised markets. The already massive Government aid given to nuclear power already corrupts and distorts the whole electricity sector in the EU.

85. With regard to this issue, attached is a report on EU's subsidies to dirty energy industries (including the nuclear sector) - '*Invest in a Clean Energy Future*' from Greenpeace International - as part of this submission.

86. As noted earlier, the commercial sector and utilities have been reluctant to invest in new build because of technical hitches, long licensing procedures, legal challenges – and concerns that they won't get a good rate of return and/or dividends. It is unlikely therefore that a significant number of new reactors would be ordered without further direct or indirect subsidies and support mechanisms being made available to the utilities.

87. The nuclear industry has pointed to the subsidies and arrangements used to help stimulate the renewables industry to justify its demands for yet more subsidies. Examples of past, and continuing, subsidies include:
    - Funding liabilities
    - Funding R&D
    - Funding R&D via International/regional treaties under the International Atomic Energy Agency (IAEA) and Euratom
    - Underwriting insurance under the liability treaty

88. The extent and nature of additional financial support for new build would most certainly be subject to scrutiny by the European Competition Commission. (More detailed information on current subsidies and state aid issue for the UK industry is included under TOR 2.2 on pages 22-30).

89. The general public and Parliament rightly have concerns over state aid. For any industry receiving state aid, Parliament might legitimately ask: Who controls it and does the taxpayer get a good/any return on investment?

90. If however the Government did choose to support the development of new nuclear power it could do so using a variety of mechanisms. These are included below. The impacts that these would have and the costs vary considerably: as some would have 'upfront' cost implications (capital grants) while in other cases the charges would be passed directly onto the consumer e.g. nuclear obligation.

State aid issues

Capital Grants

91. The Government could award capital grants for new construction. In France, the new EPR project at Flamanville is expected to receive around €500 million in capital grants from the Government. Similarly, in the US, the Government is offering specific funds for the construction of the first few reactors. As can be seen from the comments by the Congressional Budget Office in 2003, there are very real risks in loan default on these projects and in the Government recovering only part of its capital grants from new build.

Government loan guarantees

92. US proposals this year to give Westinghouse a $5 billion loan guarantee created controversy - not only because this is the largest loan guarantee ever put forward by the US Export-Import Bank - but also because it was (ironically) seen as a subsidy to the UK Government as Westinghouse is owned by BNFL.[34] If Westinghouse is not sold[35] there is a possibility it could apply to the UK Government - via BNFL - for loans for future reactor building projects either here or overseas. As noted in the DTI's document on the strategic review of BNFL[36]:

93. *"The review has concluded that only limited synergies exist between Westinghouse and other BNFL business units, including those concerned with UK clean-up.* ***Westinghouse does, however, rely heavily on its parent for guarantees and other balance sheet support in relation to both its site clean-up obligations and some contracts with its customers."*** (emphasis added).

94. Similar arrangements for Government loan guarantees exist across the nuclear sector internationally. Any future application for new build in the UK – either by a UK or foreign company – would have to be carefully examined to ensure that state aid funding is not distorting the market.

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[34] Platts Nuclear News Flashes 18/2/05 *Westinghouse received US Export-Import Bank backing for nearly $5 billion.*

[35] The original loan guarantee for Westinghouse was for reactor building in China. This has now been blocked in the US because of concerns over technology transfer. If Westinghouse doesn't have any reactor sales on its order books it may not reach the asking price of £1 billion – and the sale may be deferred until it can reach a better price.

[36] Conclusions of BNFL Strategy Review: Explanatory Note, November 2004 http://www.dti.gov.uk/nuclearcleanup/ach/explanatorynote.doc

Cost Over-Run Guarantees

95. Utilities may seek Government assurances that they will be compensated for any time or cost over- runs resulting from extended licensing processes. In the US it has been suggested that the Government could pay interest on any capital as a result of construction over runs due to unforeseen legal challenges.

Tax Breaks

96. The nuclear industry could become tax exempt, deferred or have reduced rates. This could be at a local level, through adjusted business rates – as has already occurred on occasions - or nationally. Tax breaks might also be given on construction capital.

Public Private Partnership

97. Public part-ownership of future stations could be introduced. This would reduce the upfront capital expenditure of the utilities, but may not be considered attractive for either the utilities or Government.

98. Public/private partnerships involving Government loans have been recommended against by the CBO in the US for 'first of a kind reactor' as the CBO believes the risk of default on the loan is too high.

Waste Fund

99. The Government has established a Nuclear Decommissioning Authority (NDA) which is responsible for historic nuclear waste. The UK Energy Act 2004 allows for the Secretary of State to use discretionary powers to direct the NDA to fund the liabilities of private nuclear operators. During debate on the Act in the House of Lords it was conceded that it was precisely because of the problems with BE that these powers had been put in the Energy Act (for further details see Appendix 1 on Segregated Funds).

Nuclear Obligation

100. Currently some countries, mainly the UK, have requirements for utilities to produce a specific proportion of their electricity from renewable sources. If the utility does not produce any or sufficient renewable electricity it may purchase a Renewable Obligation Certificate (ROC) to meet its target. A similar scheme could be introduced for nuclear however, this could raise a number of problems, including:

- Compared to renewable energy it is more difficult for utilities to become nuclear electricity producers and thus they will have to purchase their 'NOC' from only a limited number of producers.

- Adding a NO (nuclear obligation) would affectively ring fence another significant share of the market.

- Some see this as creating too great a distortion of the market.

Feed-in Tariffs

101. Another mechanism to support renewable energy is the use of feed-in tariffs. This guarantees investors a fixed price for the electricity produced. A similar scheme could be used to support nuclear construction. As noted earlier, the CBO

has warned the US DOE that using such a scheme to support new build would probably be more costly even than direct capital grants as the money for this scheme would have to be set aside up front – in order to assure investors the electricity would be bought at a fixed price.

102. The 5th reactor in Finland is effectively being built on the basis of feed-in tariffs, whereby the heavy electricity users are tied to fixed price contracts from the future reactor. That reactor project is the subject of a complaint to the European Competition Commission because of state aid given to help finance construction.

Licensing/siting/planning

103. The nuclear industry would like to see a streamlining of the licensing and planning inquiry processes. In the US licensed streamlining is being undertaken and is also being looked at in other countries.

104. Keith Parker, chief executive of the Nuclear Industry Association, has said "There have to be some enabling measures to give the right signal to investors. For example, there is no way investors are going to be interested when it takes six years to get planning permission for a new plant, so reform of planning law would be a good start."

105. Quite what 'reform' means in terms of reducing public input at inquiries, and local government say over planning matters, has not been spelt out by the industry.

Grid Availability

106. The incumbent nuclear generators have access to and control of the high voltage transmission wires connecting their facilities to the grid. These were constructed prior to market liberalisation. As nuclear power stations are retired then these grids connections could be made available for any other uses, such as replacement nuclear capacity or gas stations or offshore wind. The allocation of these grid connections could have a significant impact on the economics of new generation capacity.

107. One suggestion put forward by the US industry is that it should be allowed to earmark sites for future nuclear reactors now. It is not clear if this would be involved in a generic licensing arrangement covering reactors i.e. once a design is approved at Federal level it can be built at any site.

108. The industry has indicated it will probably apply to build on existing sites. Thus, if the US proposal was followed through in the UK, this could mean that even if a new reactor might be 20 years off, the site would be kept for nuclear use. Taking up sites for possible new build years into the future would effectively block access to the grid and could prove to be a major impediment to renewables developments needing to use those grid connections

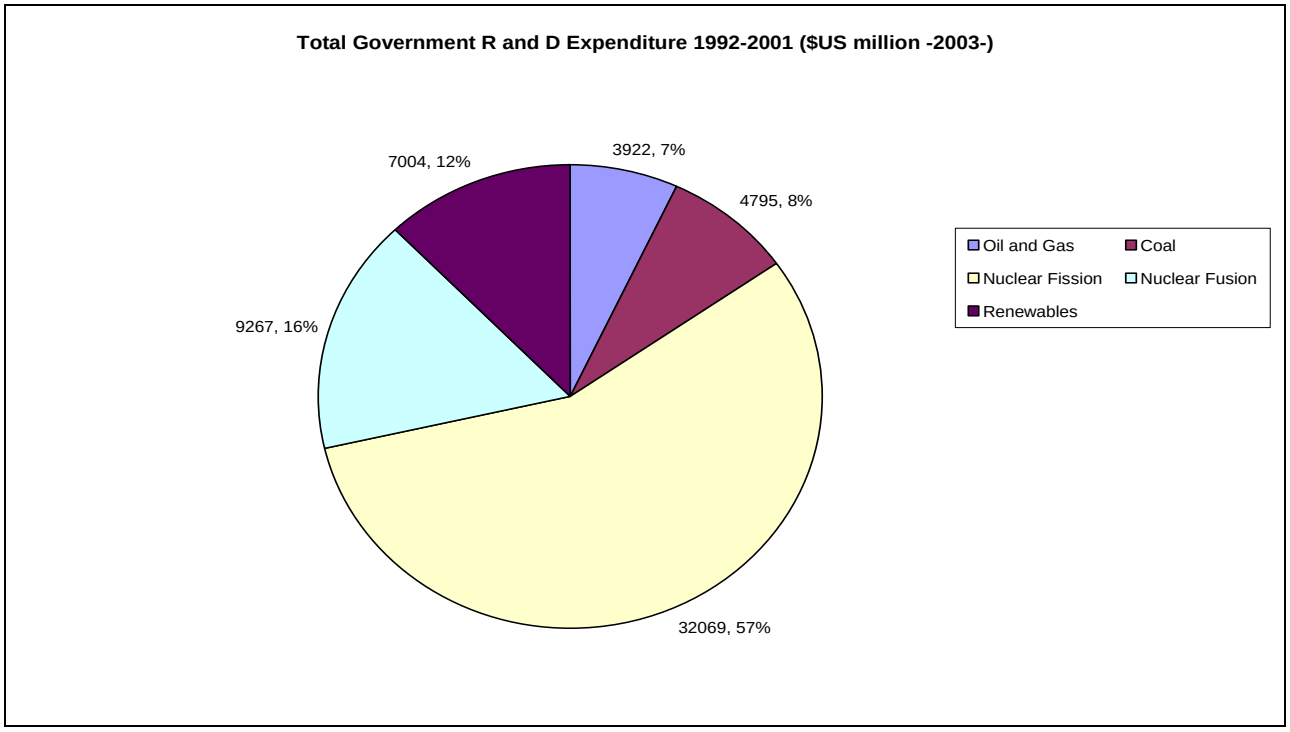
109. In addition, many nuclear communities expect to see their nuclear sites returned to 'greenfield' status or at least see total decommissioning and hazard reduction. They may not be willing to welcome a new reactor onto existing sites.

Indirect Support Mechanisms

110. Governments also have the opportunity to less directly support the development of nuclear power. These mechanisms can be extremely effective and have over the years given considerable assistance to nuclear power.

Research and Development

111. For decades Governments have given research and development funds to the energy sector. These funds are supposed to be targeted towards the development of new technologies, but as can be seen in the figures below have mainly been for the further development of nuclear fission. In total over the last decade 75% of funding for the development of new energy sources has gone to nuclear power. Another example of R&D support includes funding university research programs. In the US $21million was awarded last year to work related to nuclear energy development.[37]



Source: International Energy Agency 2005

Examples of state aid in Europe

112. The industry has given the impression that new reactor programmes in Europe are being built without state aid. That is not the case.

113. The industry has also made much of the 5th reactor being built in Finland as a sign of the industry's renaissance. That reactor project is however the subject of a

[37] Nuclear News Flashes, 23 December 2004, *Thirty-Five DOE nuclear research grants awarded to 25 universities*

complaint to the European Competition Commission on possible illegal state aid funding from several countries.[38]

114. France's proposed new reactor is also receiving capital grants of 500 million Euros, and probably other state aid subsidies will follow for liabilities.

[38] For full text see of EREF complaint see: http://www.eref-europe.org/downloads/pdf/2004/EPR_Finland.pdf

Cost overruns and lack of liability funding

TOR 2.2
With regard to nuclear new build, how realistic and robust are cost estimates in the light of past experience? What are the hidden costs (e.g. waste, insurance, security) associated with nuclear? How do the waste and decommissioning costs of nuclear new build relate to the costs of dealing with the current nuclear waste legacy, and how confident can we be that the nuclear industry would invest adequately in funds ring-fenced for future waste disposal?

115. The short answer to this is no, the industry has not shown itself to be good at estimating construction costs and providing funding for decommissioning and waste liabilities.

How realistic and robust are cost estimates?

116. As seen from information provided in pages 3-12, cost estimates are just that – estimates. The actual price of a reactor may be far more than the original figure quoted. This is true for a number of UK nuclear projects.

Sizewell B

117. Capital costs increased from £1,691m to £2,030m (1987 prices) according to a paper produced by Brian George for a CEGB Board meeting on 7th June 1990. The revised figure did not allow for inflation, which if included would have meant a total for final payments of £2,621m. Nor did the revised figure include interest payments, which would bring the figure up to between £3,501m and £3,611m. Finally, it did not include £199m written off through 'more prudent accounting policies', which covers delays in commencement arising from the public inquiry. If included this would bring the total to £3,700m to £3,810m.[39] Indeed the House of Commons Energy Select Committee said that "objectors at the Sizewell B Public Inquiry predicted the likely costs more accurately than the CEGB itself".Sizewell B opened on 31st January 1995 6-12 months late.

Torness

118. It has been reported that sources in the Scottish Civil Service admitted in 1989 that the Torness nuclear power station, was 'a £2500m mistake'.[40] The station was originally projected to cost £742 million. The Scottish Office's admission that Torness should never have been built in the first place coincided with the announcement that the UK's nuclear stations would not be sold off with the rest of the electricity industry.

119. Construction of Torness began on Monday 13th November 1978. The first reactor went critical on 25th March 1988 – a total of eleven years to build and start operation. The South of Scotland Electricity Board had said it was confident Torness could be built in six years, compared with a minimum of nine years for previous AGRs. It was plainly wrong.

[39] House of Commons Energy Select Committee Fourth Report, the *Costs of Nuclear Power*, June 1990.
[40] Alf Young, 10th November 1989, "*Torness plant was 'a £2500m mistake'* Glasgow Herald.

Dungeness B

120. Dungeness B took 23 years to complete, instead of the 5 predicted and costs were 400% above the original projection.[41] One recent newspaper report notes that selecting and persisting with AGRs was, according to economist John Kay, "probably the worst economic decision ever made by a rich state".[42]

THORP

121. According to figures given at the 1977 public inquiry for the Thermal Oxide Reprocessing Plant (THORP) at Sellafield, the plant was expected to cost £300m. It was originally due to start operating in 1987, but by its completion in 1992 costs had risen to £1.8 billion. With the additional costs of associated facilities, including new waste treatment buildings, the total bill reached £2.8 billion.[43]

122. The plant was expected to have a working life of 25 years, but is likely to close after less than 20. BNFL argued that its income from reprocessing 7,000 tonnes of spent nuclear waste fuel over THORP's first ten years of operation would be sufficient to cover all capital costs, as well as operating and future decommissioning costs, *and* make a profit of £500 million. THORP eventually began operation in April 1994, but by April 2004 had still not completed its 7,000 tonnes of baseload contracts. By the time THORP was closed this April to due a massive internal leak caused by a fractured pipe, it was estimated to be around 2 years behind schedule in projected reprocessing throughput. Revenue losses from THORP's non-operation this year have been put at around £300M - with the costs of repair yet to be added.

Sellafield MOX Plant

123. In November 1996, when BNFL applied to the Environment Agency for an authorisation to discharge radioactive waste from the Sellafield MOX Plant (SMP), construction was virtually complete and had cost £300 million. Subsequently the construction costs of the SMP were disregarded in any assessments of the economic case for SMP, because by the time of the application the costs had already been incurred and were, therefore, considered to be 'sunk' costs. A further £170 million was spent between December 1997 and July 2001 on commissioning costs (and was therefore also considered to be a sunk cost). Arthur D Little produced an assessment of the economic benefit of operating the plant in July 2001, which concluded that operating the plant would produce a net present value of £159 million compared with a loss of £58 million if the plant did not operate.

124. ADL concluded that the key threat to achieving its predicted outcome was if SMP failed to meet the timetable for the first deliveries because of a delay to commissioning, or a delay to the start of Japanese deliveries.[44]

125. The first MOX fuel assemblies did not leave the plant until 28th May 2005. Technical problems since the first plutonium test material was introduced into the

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[41] New Economics Foundation, *'Mirage and Oasis – energy choices in an age of global warming'* http://www.neweconomics.org/gen/uploads/sewyo355prhbgunpscr51d2w29062005080838.pdf

[42] *Over-reaction* 12/08/2005, Telegraph http://www.telegraph.co.uk/opinion/main.jhtml?xml=/opinion/2005/08/12/dl1202.xml

[43] Aubrey, C, THORP: *The Whitehall Nightmare,* Carpenter 1993.

[44] DEFRA, DoH (July 2001) *Assessment of BNFL's Business Case for the Sellafield MOX Plant*.

plant 42 months earlier prevented the plant from fully operating until early 2005. BNFL has spent an additional £100-200 million over the past three years in an effort to sort out all the technical hitches. It has had to subcontract MOX fabrication orders from Swiss and German customers to its European competitors Cogema and Belgonucleaire.[45]

126. Consequently it appears that the two main threats to SMP's profitability (assuming sunk costs are ignored) have both come to pass.

127. We have included information on THORP and SMP because although they are 'one off' projects the problems with cost and operations of these facilities are indicative of the many of the problems experienced across the nuclear field.

128. Future 'one off' projects - such as a national nuclear dump - will probably also experience the same problems. If built and operated on a user-pays basis (as some have indicated should be the case) this could add significantly to the long-term liability costs of any new build operations. Alternately the costs of the dump may be borne purely by the taxpayer under Government's decommissioning and clean-up plans and future new build may enjoy a subsidised waste disposal option.

Insurance – hidden costs

129. Insurance for the nuclear industry – in terms of underwriting compensation for an accident or terrorist attack – constitutes a subsidy to the industry. Just how much that might be is not easy to say.

130. In the section of the DTI's Departmental Report for 2005 which discusses liabilities, it is noted (page 202):

131. In addition, the Government has had to provide temporary indemnity to British Nuclear Insurers to cover terrorism risks[46]

132. It gives the figure for this as 'unquantifiable.' In short, if there is a terrorist attack and there are payouts no one knows what the full amount will be.

133. Arrangements for insurance by the Government are given on its website[47], where it notes that

134. The Nuclear Installations Act of 1965 governs liability and compensation arrangements for nuclear damage for which a UK nuclear licensee is responsible. The Act requires compensation to be paid for damage to persons or property up to a limit of £140 million by the liable operator. This limit is kept under review. For ten years after the incident causing damage, this obligation is met by the operator; between ten and thirty years afterwards, the Government must meet the obligation.

[45] *BNFL to miss target for producing first fuel at Sellafield MOX plant* Pearl Marshall, Nuclear Fuel, Vol.30 No.5 February 28th, 2005
[46] DTI department report 2005- P 202
[47] http://www.dti.gov.uk/energy/nuclear/safety/liability.shtml

Under the Act, insurance arrangements for a nuclear site must be approved on behalf of the Secretary of State for Trade and Industry before a site licence is granted to the operator of a nuclear installation. The licensee requires £140 million of insurance or other financial security to cover his liability under the Act, including for transport of nuclear materials.

135. The impacts of a major nuclear accident or terrorist attack could be massive. In the short term, remedial action and compensation costs would in all likelihood cost far more than £140m – which would mean the taxpayer would fund the difference. In the longer term contamination and the cancer and ill-health effects which would result decades after the event would see most of the burden fall on the Government.

136. On its website the Nuclear Industry Association insists that the industry arrangements between the Government and the industry do not represent a subsidy. However, as it notes: *The Nuclear Installation Act stipulates that the plant operator cannot pay any compensation out of assets. There must be a separate financial mechanism in place to cover this.*[48]

137. Why should the assets of a plant operator – shares, other companies, financial holdings - not be accessed to pay out compensation?

Security - hidden costs

138. Costs for security for the nuclear industry are not easy to come by. In its 2005 Annual report the DTI gives a figure of £6million for the Civil Nuclear Police Authority (DTI Departmental Annual report, p 193). Costs for the Office of Civil Nuclear Security (2002-2003) were £18 million. It is not known exactly how much is contributed by private companies such as British Energy or a Government owned commercial entity such as BNFL for security.

139. There will also be 'hidden' costs for nuclear security as a range of authorities (police, military, emergency services, health and local authorities) all have to devote time and resources to planning for nuclear accidents and terrorist attacks. This would not apply to the renewables sector – or to a decentralised energy system.

How do the waste and decommissioning costs of nuclear new build relate to the costs of dealing with the current nuclear waste legacy?

140. The Committee asked how a new build programme might impact on the current waste legacy. As with all things nuclear there is no easy answer to this. With regard to giving firm figures on the costs for waste and decommissioning for new build it is virtually impossible to answer this. There main problems in determining the cost of decommissioning, clean-up and waste/spent nuclear fuel liabilities is because these are dependent on:

- the scale of the new build programme proposed;

[48] http://www.niauk.org/article_56.shtml

- the size of reactor e.g. 1GW or 1.3GW;
- reactor operational life;
- type of reactor;
- siting issues; and
- whether disposal of all types of waste will be a reality by the time the reactors are commissioned – which could mean major infrastructure costs like a national repository or store have already been financed by the taxpayer.

NDA – scale of current liabilities

141. Recently published estimates by the NDA indicate an expected £56 billion (an increase of £8bn over the figure of £48 billion given last year) for decommissioning and clean-up of the nuclear installations it has taken charge of. These figures do not include British Energy's plants, which are covered under a separate arrangement. The DTI's annual report 2005 states that 'various constructive obligations relating to the restructuring of British Energy' are estimated at £3.912 billion. If BE cannot fund its future liabilities under the new arrangements (see Appendix 1) then the taxpayer will have to fund this under clauses in the Energy Act (this would be done via the NDA).

142. The £56 billion may not be the final cost as, according to the NDA's strategy, future costs depend on many variables e.g. dumping Intermediate Level Waste by 2025 is claimed to be cheaper than storage (and – it is claimed – will impact on the cost of Magnox decommissioning.

143. The NDA has also said that disposing of plutonium as a waste could add several billions to its costs. However, that cost would have to be set against the cost of constructing reactors and burning the plutonium in MOX fuel (see below) which would have significant environmental risks and impacts e.g. MOX spent fuel is more radioactive than 'ordinary' uranium spent fuel. Burning MOX also has additional security measures (and therefore costs) associated with it.

144. The DTI cannot give a figure for nuclear liabilities it is responsible for, stating that these are 'unquantifiable'.[49] In the report under 'statement on contingent or nominal liabilities (Nuclear) it noted:

145. The Department has a range of civil nuclear liabilities arising through its association with UKAEA and BNFL as well as ensuring that HMG complies with its obligations under various nuclear international agreements and treaties. The amount and timing of this overarching liability is not quantifiable.

Nuclear Wastes from new build.

146. The quantity of waste estimated to arise from a 10 AP1000 reactor power programme is estimated at

[49] DTI department report 2005- P 202

100,000t depleted uranium;
31,900 m^3 (14,000t) spent fuel;
6,000m^3 ILW; and
85,000m^3 LLW. [50]

147. The quantities of ILW and LLW are less than 10% of the volume of waste reported in the 2001 UK Radioactive Waste Inventory – but the spent fuel produced would be a massive 400% extra above the estimates 8,150 m^3 from the current programme.

Spent fuel: – a case in point in problems of determining the current *and* future costs.

148. We provide below an example of what's happening at present with spent nuclear fuel from BE and then consider the amounts of spent fuel that would be created through a new build programme.

Spent fuel costs

149. Greenpeace commissioned a paper for the European Competition Commission's investigation into the restructuring and state aid package for British Energy looking at the reduced-cost reprocessing contract BNFL and BE had negotiated.

150. That report explained that BNFL is only charging £150,000 per tonne for spent fuel services but that this was not a commercial deal as spent fuel services could cost between £330,000 to £533,000 per tonne. The lower price offered by BNFL therefore represents state aid from the government to British Energy.

151. The £150,000 BE pays to BNFL for it to manage each tonne of spent fuel is the only payment it makes for spent fuel services. BNFL assumes ownership of the spent fuel when it is delivered and BE has no further liability. BNFL will presumably have to find the money for the costs and risks of disposal – possibly an extra £220,000 per tonne (Harvard estimate) or £423,000 per tonne (Nirex estimate).[51] It is not clear at present however, if it is the NDA or BNFL which will now have to take over whatever additional costs there are in managing this fuel.

THORP shutdown – more problems?

152. The closure of the THORP plant at Sellafield, and how it might impact (or otherwise) on what BNFL and the NDA decide to do with spent fuel being received from BE plants is something that cannot yet be answered. A change from reprocessing to storage may not cost BE any more money – but could mean

[50] NIREX 7 July 2005, Volumes of radioactive waste predicated to arise from a programme of 10 AP1000 reactors

[51] *Restructuring Aid for British Energy: Issues for the European Commission*, National Economic Research Associates (NERA). Gordon MacKerron, March 2004. http://www.nera.com/Publication.asp?p_ID=2063
Response to Questions Raised Based on Reference 334004. Nirex Letter to RWMAC. November 2000.
The Future of Nuclear Power: An Interdisciplinary MIT Study
Massachusetts Institute of Technology. July 2003. http://web.mit.edu/nuclearpower/
The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel. Belfer Center for Science and International Affairs. M Bunn. Harvard University. December 2003.
http://www.puaf.umd.edu/faculty/papers/fetter/2004-NT-repro.pdf

additional funds having to be found by the NDA (i.e. taxpayer) to fund storage facilities.

153. If THORP is reopened it might well be at considerable cost – another financial burden which will fall on the NDA as the plant's owner. It is estimated the closure of THORP will cost £300million in lost revenue this year.

Plant life extension

154. BE has recently announced it will be extending the life of the Dungeness B plant by 10 years. The additional spent fuel created will be sent to Sellafield. Some funding to cover the costs for this additional spent fuel should come from BE under the restructuring agreement. However, as explained shown above the amount BE pays for BNFL/NDA to receive the spent fuel will not cover long-term storage *and* disposal costs.

Massive increase in spent fuel holdings under new build

155. It is vital to consider not just the volume of radioactive waste from a new build programme, but also the amount of radioactivity contained within the wastes.

156. Spent fuel is the most problematic waste from reactors because it is heat-generating (extremely hot in fact), is intensely radioactive and contains very long-lived radioactive elements.

157. The latest radioactive inventory from the Committee on Radioactive Waste Management (CoRWM) provides the most up-to-date estimates for the wastes arising from a programme of building and operating 10 new reactors (based on a 60 year operating life) as:[52]

- Spent fuel arising from current programme: 8,150 m^3cubic metres
- Additional spent fuel arising from 10 new reactors 31,900 m^3cubic metres.

158. This is a **400%** increase over and above expected spent fuel arising from the existing plants (CoRWM also estimates a programme of plant life extension for all of BE's plants could result in an additional 1,520 m^3 of spent fuel – a 25% increase to the baseline inventory).

159. The industry has constantly put forward the figure of 10% in terms of new waste arisings from a new build programme – that figure relates only to the additional amount in terms of overall volume. The industry is seeking to avoid debate over the fact that there will be a huge increase in spent fuel – the most hazardous and long lived of radioactive wastes from reactors – if there is a new build programme.[53]

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[52] Summary of inventory: http://www.corwm.org.uk/pdf/1280%20-%20Task%20088%20CoRWM%20Inv%20July%202005%20Summary.pdf.
Document explaining basis for assumption of 60 year reactor lifetime
http://www.corwm.org.uk/PDF/1277%20-%20Task%20088%20Study%20Report%20Final%20Draft.pdf

[53] High level liquid waste accounts for 3% of the volume of a spent fuel rod, but contains 97% of the radioactivity, arises from reprocessing.

160. CoRWM is to be commended for putting together these more comprehensive reports on the potential for new build to impact on the UK's radioactive waste inventory.

How much additional radioactivity from new build?

As the latest inventory from CORWM notes:

161. 'The only scenario that would change the baseline inventory radioactivity to any significant extent is that where there is a commitment to future nuclear energy with life extensions to existing AGR and PWR stations and a programme of new reactors. In this scenario the amount of radioactivity (and the quantity of spent fuel for long term management) could be up to a factor of five greater than the baseline.'

162. The baseline line inventory for *all* nuclear wastes in the UK is estimated to contain 78,000,000 TeraBecquerels (TBq) of radioactivity (see CoRWM inventory)

163. The extra radioactivity coming from spent fuel from new build would be 130,000,000 TBq. This would increase the total amount of radioactivity in the inventory of UK nuclear wastes from 78,000,000 TBq to 208,000,000 TBq

164. To 'sell' a programme of new build that will create so much more highly radioactive and hazardous waste would be a massive issue in terms of public perception.

165. It's hard to see how the industry and Government will persuade people to accept a new build programme when they already have such major problems with gaining consensus over what to do with the current waste stockpile.

166. With regard to this, it's also worth noting that because of the costs, proliferation and environmental problems associated with reprocessing a 'once-through' cycle is being proposed for new build spent fuel – no one is reckoning on reprocessing over the coming decades

Disposal or storage of spent fuel?

167. Spent fuel is the most hazardous material produced by nuclear reactors[54]. There are no disposal options available for spent fuel, although the impression given by industry is that this matter has been resolved in other countries.

168. Finland is still very much in the exploratory stage of its national repository, the same for Sweden. Neither country has a working spent nuclear fuel or high-level waste repository. Only recently the US has run into problems – again – in constructing the Yucca Mountain high-level waste store (to the point that there are currently proposals in the US to ship spent fuel to France or the UK to help reduce stockpiling of spent fuel at US reactor sites).

169. NIREX has admitted that no final waste repository is likely to go ahead for the next 25-40 years. In its most recent strategy the NDA does not raise the issue

[54] High level liquid waste is produced during reprocessing of spent fuel when the plutonium and unburnt uranium is separated out.

of spent fuel disposal, whether this is because it believes this is not an issue which is relevant to the next five year to be covered by the strategy is not clear.

170. BNFL/Westinghouse has published a document which indicates that it believes storage at the reactor site to be the most likely management option for spent fuel at new reactors.[55] In discussing radioactive wastes produced by reactors it has stated:

171. 'In addition spent fuel can be safely stored for at least a century on the reactor site making a new build programme independent of a long term solution. Effort and resources that are being devoted to addressing the waste "legacy" from earlier national programmes must therefore be clearly distinguished from waste management activities for new commercial reactors'.

172. This is interesting coming from a company (BNFL) which has hitherto always claimed reprocessing is the best option for spent fuel.

173. This proposal also shows how cynical the industry can be. On the one hand a number of industry commentators have claimed that direct disposal is the best option for spent fuel and have recently seized on the security risks to waste stores in order to push disposal (and also, coincidentally 'solve' the political issue of radioactive waste at the same time).

174. But when it comes to having to explain what to do with the massive amounts of spent fuel that would be produced by a new build programme – and in order to dodge the thorny question of there been no spent fuel disposal programme – suddenly storage for 100 years is ok! Whether the residents living around potential new build sites would have quite the same view is another matter (more detailed points on public opinion on radioactive waste are made in discussion under TOR 7, page 38 of this submission)..

175. Spent fuel stores are also important in the context of the security debate. Spent fuel stores can contain many times the amount of radioactivity of that released during the 1986 disaster at Chernobyl and an attack – or accident – at a store could lead to widespread contamination and could result in hundreds of thousands of deaths. [56]

How confident can we be that the nuclear industry would invest adequately in funds ring-fenced for future waste disposal?

Background and current situation

176. There is a long history of state aid to the industry to help with liabilities which continues to this day and will continue for some decades to come for existing nuclear companies such as BNFL and British Energy.

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[55] BNFL (5th September 2002) "Nuclear Now for tomorrow's generation: BNFL Submission to the Consultation on UK Energy Policy" http://www.bnfl.com/library/upload/docs/001/222_1.pdf

[56] Greenpeace International Reactor Hazards Report http://www.greenpeace.org/international/press/reports/nuclearreactorhazards

177. This has given rise to expectations within the industry that such support will be available in the future. In fact, the industry is actively lobbying for financial subsidies for reactor construction and liabilities. It will resist any changes to legislation to make segregated funds a legally binding requirement for nuclear liabilities.

178. The industry claims it prefers the 'flexible' approach taken to date – which has invariably left the taxpayer funding a major part, or all of, the industry's liabilities. The actions of successive Governments (including the current one) have not been to ensure the public purse is protected. Instead, the industry has been bailed out time and time again, with no legislative changes made to prevent similar occurrences to BE's bailout happening in the future. In fact only last year the Government passed legislation which will allow for the bailout of future private nuclear operators if they too fail to sufficiently fund their liabilities.

British Energy

179. With regard to British Energy there is evidence of a major failing on the part of the DTI to monitor the company [57] and the Department has been criticised by the National Audit Office and the Public Accounts Committee for its lack of oversight of BE. [58] (See Appendix 1 on segregated funds).

180. Due to BE's failure to properly fund its liabilities, the state aid subsidy for this now stands at £3.9 billion (DTI Department report 2005). However, if BE fails to put aside sufficient funds for future waste costs it will – as Appendix 1explains – be bailed out yet again by the taxpayer via the NDA. Provisions included in the Energy Act 2004 allow for the Government to bail out any future nuclear private operator if they too fail to meet their liabilities (See Appendix 1).

181. Surprisingly though, the Energy Act allows for the Secretary of State to direct that wind plant decommissioning funds have to be paid up front for wind turbine projects, even though no such rule exists for nuclear power.

NDA & BNFL – state aid investigation – another example of bad prediction

182. Apart from the problems with monitoring and assessing the risk from BE's failure to properly fund its liabilities, the DTI also appears to have failed to fully appreciate the problems of the movement of assets and liabilities from BNFL to the NDA and whether or not this could simply pass as an unchallenged state aid measure.

183. In September of last year senior DTI officials (some of whom are now senior NDA officials) told Greenpeace and other NGOs there was no problem with the transfer of liabilities from BNFL to the NDA and that they were confident this matter would not be investigated by the European Competition Commission (DTI had notified the EC of the transfer).

[57] NAO, 6/2/04 http://www.nao.gov.uk/publications/nao_reports/03-04/0304264.pdf and PAC http://www.publications.parliament.uk/pa/cm200304/cmselect/cmpubacc/354/35402.htm
[58] NAO, 6/2/04 http://www.nao.gov.uk/publications/nao_reports/03-04/0304264.pdf and PAC http://www.publications.parliament.uk/pa/cm200304/cmselect/cmpubacc/354/35402.htm

184. A couple of months later the same officials were having to explain to Greenpeace and Friends of the Earth that the Competition Commission was indeed calling in the transfer of liabilities as part of a state aid investigation into the NDA.[59]

185. The initial attitude of officials to the legality of the BNFL liabilities transfer proposal seemed a little blasé given that Greenpeace had submitted an opinion to the Commission, from a leading state aid legal expert, that the legislation covering the NDA was illegal under state aid and competition rules. That there was no possibility of the transfer deal being questioned either exposes a lack of understanding of these issues by the DTI, or over-confidence on its part.

186. Either way, the NDA/BNFL state aid case investigation is yet another example of how senior departments may get it very wrong about how much money the nuclear industry can simply take from the taxpayer. Future provisions by Government to support the industry might also be challenged by the Commission – something the investment community will doubtless be aware of but which the Government may be badly advised on by overly optimistic advisers. The EC's investigation on the NDA and state aid is still ongoing. Its conclusions are expected any time between December and June 2006.

187. In the meantime the NDA has been unable to take over full ownership of Sellafield's liabilities from BNFL because of the ongoing European Commission (EC) investigation.[60]

Ring fenced funds?

188. This is explained more fully in Appendix 1. In brief the views are as follows:

189. Industry view: It sees the need to repay capital and provide dividends to investors before putting sufficient money aside for decommissioning and waste. Its general views is that it is safe to put off greater funding for liabilities into later in the reactor's operational life and that it will have plenty of time to set aside money from profits made during that time. It doesn't want mandatory legislation on this issue, as it believes it would put investors off if they had to wait longer for a return on capital and accept lower dividends if larger amounts of funding are 'diverted' earlier into liability accounts.

190. Environment groups view: From the moment a reactor is commissioned and starts operating it creates a large, contaminated building and produces spent fuel. Adequate funds should therefore be put aside from the very beginning to cover liabilities. Relying on the industry to put money away in later years assumes that the reactor will have all the later years necessary in which to produce profits (and not have any costs for repairs/technical changes), which may not be the case.

[59] Greenpeace's submission on this can be found at http://www.greenpeace.org.uk/contentlookup.cfm?CFID=1230708&CFTOKEN=91665436&ucidparam=20050901122409&MenuPoint=D-E-F

[60] Nuclear Fuel (Vol. 30, No.8) 11th April 2005

191. Pension funds: A simply analogy is that of an individual considering putting money aside for a pension. Do they spend money on holidays and paying off the mortgage in the early years of their working career, or contribute towards a pension over a longer period throughout their whole working life? As we know the Government encourages the latter and is actively promoting early provision for pensions. As with the individual, the nuclear industry just can't rely on a state pension (aka liability bailout) to get it out of trouble in its later years.

CO_2 emissions and nuclear power

TOR 4.1

192. To what extent and over what timeframe would nuclear new build reduce carbon emissions?

193. The UK's fleet of 23 operating nuclear reactors currently provides 22% of the UK's electricity. But it has to be remembered that power stations are responsible for less than 30% of the UK's CO_2 emissions. Nevertheless without these reactors the UK's CO_2 emissions would rise by about 10% (around 6%-7% of total greenhouse gas emissions). All but five of the current generation of reactors are due to close by 2020. The nuclear industry's proposal to build ten AP1000MW reactors[61] would effectively replace all the current reactors.

194. But building 10 new reactors would not make a big dent in the UK's CO_2 emissions and by 2020, because of the changing fuel mix and increasing energy efficiency, the CO2 offset would be much less than 10%. Using DTI figures, Greenpeace estimates that a new 10,000MW nuclear power programme would reduce emissions by around 6 – 8 MtC depending on the output (i.e. around 1MtC per 10TWh of output).[62]

195. Putting this 6-8 MtC into perspective, it would represent around 4 - 5% of total carbon emissions in 2020 or around 3 - 4% of total UK greenhouse gas emissions (around half of the increase in emissions expected from the transport sector by 2020). Because of this, some commentators have proposed that instead of just a replacement programme, there should be a massive expansion in the amount of nuclear power in the UK. One senior government official has gone so far as to suggest a programme of 45 new reactors, which it is estimated could supply 50% of the UK's electricity. In theory this would reduce UK's CO_2 emissions by 60% by 2050[63] (this figure is dependent on projections for energy mix by 2050 and also on the capacity of reactors installed).

196. It has been reported that IAEA has stated it does not believe nuclear power could not grow fast enough over the next decades to slow climate change across the globe.[64] The IAEA report considered two scenarios.

1. Nuclear energy continues to decline, with no new stations built beyond those already planned. Its share of world electricity - and thus its relative contribution to fighting global warming - drops from its current 16 per cent to 12 per cent by 2030.
2. Nuclear power grows by 70 per cent over the next 25 years but its overall contribution to electricity – and thus to reducing CO2 emission is less under this scenario because the world would have to be so prosperous to afford the expansion

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[61] BNFL (5th September 2002) "*Nuclear Now for tomorrow's generation*: BNFL Submission to the Consultation on UK Energy Policy" http://www.bnfl.com/library/upload/docs/001/222_1.pdf

[62] DTI (2000) Energy Paper 68: '*Energy Projections for the UK'* http://www.dti.gov.uk/energy/inform/energy_projections/index.shtml

[63] *Britain must go nuclear, energy chief tells ministers*, Angela Jameson, Timesonline 14/9/2004. http://www.timesonline.co.uk/article/0,,2-1261215,00.html

[64] *Nuclear power 'can't stop climate change'* By Geoffrey Lean, Environment Editor 27 June 2004

that traditional ways of generating electricity from fossil fuels would have grown even faster.

Security of supply

TOR 4.2
To what extent would nuclear new build contribute to security of supply (i.e. keeping the lights on)?

197. Greenpeace does not believe nuclear power can form any part of the solution – indeed it is very much part of the problem. For Greenpeace's part, the question is not so much whether new build would contribute to security of supply, but that investing huge amounts of money into an unresponsive (timeline wise) and inflexible centralised system with inherent safety and security risks would actually undermine security of supply. In Part 2 of this submission the alternative route for securing electricity supply is discussed in more detail.

198. To use another financial investment analogy. If someone were to be advised to invest all their money into one high risk venture that might pay off decades into the future but which also had the potential for significant losses – in fact has the potential to accrue liabilities and risk a massive and sudden depreciation of capital – then that person would walk away from the investment adviser (in fact this is exactly why investors are not queuing up to fund new build).

199. Isn't it better to invest in a mixed portfolio which had assured returns (renewables), or undertake measures which offer longer-term cost reductions and savings (energy efficiency) than one big risky venture? The same is true of financial capital as energy capital.

200. We simply do not have the time and therefore cannot take the risk on a reactor programme that might not work decades after we've decided to place all our faith in it.

New Build: Proliferation, terrorism *and* security?

TOR 4.3
Is nuclear new build compatible with the Government's aims on security and terrorism both within the UK and worldwide?

201. The short answer is no. The security problems brought by the proliferation and terrorism risks certainly mitigate against nuclear power as a suitable energy source.

202. The Government should move to guard against the potential for proliferation problems brought about by encouraging and trading in dual use civil and military nuclear technologies through developing and promoting renewable energy and decentralised energy systems worldwide. It should set an example by closing nuclear facilities here as soon as possible – which would also serve to reduce the risk of a terrorist attack by decreasing the number of targets.

Proliferation

203. As part of this submission Greenpeace has attached a briefing on proliferation which explains in broad terms the difficulties in the promotion and trade of dual-use civil and military nuclear technologies and materials.[65] In particular it explains the complex and often contradictory nature of the remit of the International Atomic Energy Agency and the objectives of the Non-Proliferation Treaty and explains the many challenges to the international non-proliferation regime. Adding to these through the massive export of nuclear technologies and materials by encouraging all countries to 'enjoy the benefits' of nuclear power would create many, many more problems than it would solve

204. Certainly, changes could be made to tighten up in many areas of the current regime e.g. putting all technology transfer under a legal system similar to the (flawed) system of plutonium and uranium sales between NPT states. Unfortunately, whatever changes are made will not resolve or eliminate the proliferation risks of nuclear power.

205. We also attach some articles which highlight some of the political problems related to the spread of nuclear technology, how it can lead to the risks of proliferation and the problems in 'reining' in the nuclear threat.[66] We do not agree with all the views expressed in the articles e.g. that nuclear fuel facilities under international control would be more effective than under national control in terms of reducing proliferation. The information will serve to give the Committee some idea of the complexity of the proliferation aspects of nuclear power.

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[65] Greenpeace briefing: Proliferation: where civil and military nuclear ambitions form a critical mass http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/7217.pdf

[66] *US hopes for nuclear energy face resistance,* FT, September 19 2005 03:00.
Nuclear Weapons in Iran: Ploughshare or Sword? May 25, 2004 New York Times By WILLIAM J. BROAD
Nuclear double standards Why should some nations but not others be allowed nuclear weapons, asks Mohamed ElBaradei, director general of the International Atomic Energy Agency New Scientist, p 17, 10 July 2004.

206. Most telling perhaps is the view of the International Panel on Climate change on this issue. In discussing the idea that nuclear power might be necessary to tackle global warming, the IPCC has warned: "The security threat... would be colossal"

207. Another worrying area in terms of the spread of nuclear power is that it would require significant amounts of fuel if many countries opted for this form of electricity generation. It is believed there are insufficient supplies of uranium to fuel a massive expansion of nuclear power (or even a replacement programme for all current reactors – see following discussion on uranium). If this proved to the case it might mean that countries would opt for reprocessing programmes to extract the plutonium for use in reactors. This would add even more to proliferation concerns and the potential for terrorism if safeguards failed to keep secure materials which could be used in 'dirty' bombs or nuclear weapons.

208. Finally, proliferation is not just about nuclear technology and materials. As the Greenpeace briefing explains, the failure of the nuclear weapons states to honour the legally binding disarmament obligations under the Non Proliferation Treaty have, and are being, used as both a justification and incitement by other countries to gain nuclear weapons.

Terrorism

209. It is extremely difficult to give a definitive answer on whether new build would result in more terrorists attacks aimed at nuclear installations. After 9/11 the nuclear industry finally, publicly, acknowledged that nuclear power plants, nuclear waste and spent fuel transports, and waste facilities should all be regarded as terrorist targets.

210. It appears there is increasing concern over the risk of a terrorist attack on a nuclear installation. Reports from governments around the world indicate this is high on the political agenda.[67] Hardly a day goes by in recent months that a story concerning either the risks of terrorism to nuclear plants.[68]

211. Late last year the IAEA appealed for money to update its computer system so it can more effectively track nuclear materials, admitting that the current system is outdated and is not modern enough for effective inspections.[69] The UK's Office of Civil Nuclear Security has recently decided to post armed police around all the nuclear reactor sites in the UK – so significant is the security threat to these sites.[70]

212. Speaking at a conference in Ireland earlier this year, US nuclear specialist Dr Gordon Thompson explained how terrorists could attack a nuclear installation as a

[67] *Annan: Nuclear terror a real risk*. BBC news, 10th March 2005

[68] e.g. *Are these towers safe? Why America's nuclear power plants are still vulnerable to terrorist attack – and how to make them safer*. Time Magazine 20 June 2005

[69] IAEA says nuclear security fund healthy but constrained by donors, Independent on Sunday, 20 October 2004.

[70] *UK upgrading nuclear security by posting armed police at sites*, Nucleonics Week 27th January 2005.

'pre-deployed nuclear weapons' and discussed the potential impact of such an attack.[71]

213. Having more nuclear facilities or keeping existing facilities open longer would increase the likelihood of any attack and of the perpetrators being more successful e.g. more time and more targets available to attack.

214. We also refer the Committee to the Parliamentary Office of Science and Technology report: *Assessing the risk of terrorist attacks on nuclear facilities*.[72] Greenpeace presented evidence to this on the risk of aircraft being used to crash into nuclear facilities, as well as the risk of land-based attacks.

215. The impacts of any attack would, of course, be dependent on how much radioactive material was released and the plant's situation (facilities near large centres of population would mean more people would be at risk). Recent studies in the US put the health impacts of an attack on a reactor at 44,000 immediate fatalities with 500,000 long-term health impacts, including cancers. [73]

216. Nuclear facilities and transports also provide targets for terrorists wanting steal nuclear materials to use in a low-grade nuclear bomb or a 'dirty bomb'. Equally likely is that terrorists could use rockets or bazookas to attack a spent fuel transport or ship carrying nuclear materials. Such an attack could result in widespread long-term contamination; harm to the health of the population around the damaged transport – as well as serious social disruption to the affected communities.

[71] http://www.nuclearpolicy.info/Latest_News/Pr05/050307.htm
[72] POST Report 222, July 2004http://www.parliament.uk/documents/upload/POSTpr222.pdf
[73] Nuclear News Flashes - Wednesday, September 8, 2004 –A terrorist attacks on Indian Point could result in as many as 44,000 fatalities immediately and more than 500,000 long-term cancers.

CO2 emissions and the nuclear chain

TOR 6:
How carbon-free is nuclear energy? What level of carbon emissions would be associated with (a) construction and (b) operation of a new nuclear power station? How carbon-intensive is the mining and processing of uranium ore?

Uranium and CO_2

217. Nuclear power is a low-CO_2 emitter, not a CO_2-free source of electricity. This is because the nuclear fuel chain uses energy to mine, mill, enrich and fabricate fuel, to build reactors and associated waste and spent fuel stores and (if applicable) to reprocess and store/manage wastes and nuclear materials from reprocessing.

218. Some research on the CO_2 emissions from the nuclear fuel chain has been carried out. Research carried out for the European Union concluded that overall the nuclear power life cycle, produces around 50% more greenhouse gas emissions than the wind power life cycle.[74] Although this does not mean nuclear power a major source of CO2 emissions, it does serve to highlight that it does not come 'CO_2 free' as the nuclear industry would like people to believe.

219. For many years the nuclear industry has given the impression that there is an endless supply of uranium for new nuclear reactors. This is not correct, as with fossil fuels there is a limited supply of readily accessible uranium – at the right ore concentration.

220. Increasingly questions are being asked about how much uranium would be available if the industry experienced a massive expansion.

221. Last year a report by the International Atomic Energy Agency[75] on the future of nuclear power included discussion on uranium supply. The basic conclusion is that if all current plants were replaced with new reactors (operating on a 60 year life) the easily accessible, cheap reserves would be used up within 60 years.

Uranium – decreased supply, lower grades, more CO2 emissions

222. In a global setting CO_2 emissions from the nuclear life cycle are therefore likely to rise in future as the industry is forced to use increasingly poor grades of uranium – which take a massive amount of energy to extract from the ground and 'enrich' to reactor grade.

223. Using lower-grade ores leads to increased CO_2 emissions through enrichment processes and accessing remote ore bodies leads to increased costs and operational problems.

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[74] AEA Technology (1998) "*Power Generation and the Environment.*" A UK perspective. Vol 1. http://externe.jrc.es/uk.pdf
[75] http://www.iaea.org/NewsCenter/PressReleases/2004/prn200405.html

224. The CO_2 contribution to from nuclear power is in addition to the already substantial risks of accident, terrorism and radioactive waste that nuclear power presents.

Proliferation implications from plutonium use if uranium is scarce

225. The amount of uranium available also has terrorist/proliferation implications if countries opted to use mixed uranium-plutonium fuel (MOX) instead of just uranium fuel. As the IAEA mooted in its report, limitations on uranium supply may mean that countries extend the energy of uranium through reprocessing and extracting plutonium for use in fast breeder reactors (a very hazardous technology rejected by most nuclear states) or MOX fuel.

226. Thus in the UK the amount and type of uranium and therefore the energy used in making fuel, may be complicated by proposals that future nuclear power plants use of MOX instead of fuel made solely from uranium.

227. Until a reactor proposal is on the table and information provided on whether or not MOX fuel would be used it is not possible to say how much CO_2 might be used to provide the fuel to run a reactor. However, MOX fuel is dependent on:

- reprocessing plants to separate out the plutonium from spent fuel (which entails a whole panoply of associated facilities which also use energy);
- a MOX fabrication plant (which, as we have seen from earlier discussion) is a costly endeavour; and
- transports from the reprocessing site to the reactor in question – which will require significant security.

228. Reliance on MOX fuel would, therefore, need more energy and create many more environmental and security concerns than the use of uranium fuel.

229. Within the UK context expanding and prolonging the nuclear industry – if in competition with other countries doing the same (or setting up major nuclear programmes) would necessitate the move towards more reprocessing and the use of fuels which have proliferation concerns as well as higher environmental risks (in reactor use) than ‘ordinary’ uranium fuel.

Uranium mining and waste

230. It is little known that in general 80% of the radioactivity in a uranium ore body remains behind in the waste tailings at a uranium mine. Uranium mining and milling is not an efficient way of maximising extraction of U-238 and U-235. In terms of overall volume uranium mining leads to the largest amount of radioactive waste in the whole nuclear fuel chain.

231. To appreciate the problems with uranium mining we refer you to a recently published report from a coalition of environment groups in Australia which explains

some of the problems experienced in uranium mining, even in a developed country.[76]

[76] *Nuclear Power: No solution to climate change,* Australian Conservation Foundation and other groups, September 2005 http://www.acfonline.org.au/uploads/res_NukesReportfull.pdf

Nuclear Waste – Public Concern and Mistrust

TOR 7
Should nuclear new build be conditional on the development of scientifically and publicly acceptable solutions to the problems of managing nuclear waste, as recommended in 2000 by the RCEP?

232. We don't know whether or not and *when* the public would be prepared to say that an acceptable solution has been found. It is quite possible that CoRWM's recommendations will resolve the issue of nuclear waste – but then they may not. Added to that, we don't know if a resolution of current waste problems would make new build acceptable, as although this is a major factor in public acceptance, it is not the only factor.

233. The Government's Energy White Paper said there are "important issues of nuclear waste to be resolved" before new build could proceed. Research carried out for the Department of Trade and Industry to inform the preparation of the Energy White Paper concluded that:[77]

"Waste Management was a dominant issue for all shades of opinion on nuclear power …"

234. But it is not clear what the public might consider to be a 'solution' to the long-term management of radioactive wastes, or when it might consider that policy implementation has proceeded far enough. This could, for example, be when (and if) a political consensus has been reached on a nuclear waste management option, or alternatively might need to wait until host communities have been found and planning consent for new facilities has been secured, or even construction of the facility, or a period of successful operation has taken place before they decide this matter is resolved.

235. Alternatively, it may be that the prevailing public viewpoint is that the nuclear waste management option, selected by the Government, is only acceptable on condition that no further nuclear waste is produced. Some evidence for this view was provided by the Ministry of Defence's consultation on the disposal of nuclear submarines – Project Isolus – which recommended that:

"The appropriate bodies should be informed of the strength of feeling against building further nuclear powered submarines, especially in relation to the absence of a final disposal route for the radioactive wastes."

236. There is also evidence from Sweden that the public acceptability of waste management proposals can be increased by setting a limit on the amount of nuclear waste which can be produced in future. For example, the 1980 referendum in Sweden, which resulted in the adoption of a policy to end nuclear power generation

[77] DTI (Sept 2002) "Integrated Public and Stakeholder Consultation to Inform the Energy White Paper: Summary
Report", IPPR, UKCEED, NEF and Dialogue by Design on behalf of the DTI.

by 2010, created the context in which better progress could be made in establishing disposal facilities. This suggests that any future waste management proposals should be combined with a well-defined nuclear closure programme so that an unambiguous picture of the type and scale of waste arisings can be presented to the public. Setting a 'boundary' around wastes arising also means there is a limit in terms of cost and defines the size of any chosen facility – which in turn would be an issue for any community asked to host a national storage or dump.

237. Greenpeace's view is that there is no 'solution' to the nuclear waste problem, only 'least worst' options. As a consequence we should stop producing further nuclear waste as soon as possible.[78]

238. It is also important to remember that CoRWM will not make recommendations about selection of a site or sites, only on which management option or combination of options it recommends. There will then have to be further public consultation on the proposed option and how it should be implemented, which could take a further two or three years. Public consensus might never be reached, which would leave the Government making a contentious decision to impose a solution.

239. Whichever management option is ultimately selected by the Government, it is likely to be some considerable time before any facility becomes available. So the nuclear waste problem, which the White Paper said needs to be resolved, will not even approach resolution until the Government decides on the best management option, say around 2008/9. It is highly likely that the public will require to see, at the very least, waste being placed in an actual facility, perhaps between 2020 and 2040, before it considers the waste problem to be anywhere near resolution. That does not fit in with the industry's timeline for new build proposals.

Public mistrust of industry plans

240. It has been acknowledged by the industry that 'solving' the nuclear waste problem is a major issue for it. On current timelines the Government could be proposing a programme of new build – with subsidies for both construction and back-end decommissioning and waste costs - at the same time the industry is looking to site a nuclear waste dump somewhere in the UK.

241. The public will be well aware that finding a solution – or giving the impression that a solution has been found (as opposed to what might prove to be a recommendation for disposal some time in the distant future) – will be no more than a cynical ploy by the industry and pro-nuclear advocates in the Government so that new build can go ahead.

242. This clash of timing will, unfortunately, undermine much of the valuable work CoRWM has done in canvassing the range of options on nuclear waste (although it should be said that it is too soon to say whether Greenpeace will agree with the

[78] Greenpeace's responses to Round One of the CORWM consultation process can be found at :http://www.greenpeace.org.uk/contentlookup.cfm?ucidparam=20050901143916&MenuPoint=D-E-F, and to Round 2 consultation process at http://www.greenpeace.org.uk/contentlookup.cfm?ucidparam=20050901145240&MenuPoint=D-E-F

recommendations proposed by CoRWM, at least it acknowledges the efforts made by the Committee).

243. Given that the industry's push to get rid of waste has, in the main, been predicated on disposal allowing it to build more reactors – and thus create more waste – the public's mistrust is clearly well founded. This is partly do to with how the industry has handled past disposal proposals via organisation's like NIREX – an organisation which is unlikely to enjoy public support or that of the environment movement if involved in future disposal plans because of the organisation's past activities (that NIREX has moved from being an industry funded body to being a government funded body has not changed this perception).

244. It will also be the responsibility of the Government and industry to explain why taxpayers should pay for disposal costs and possibly invest more money into an industry which produces hazardous wastes; which can be a target for terrorists; which creates weapons-usable materials; which operates plants which can have catastrophic accidents etc. As the sample of opinion polls given below indicates, the Government and industry have a long haul ahead of them on this issue.

Eurobarometer latest on public views on nuclear power and nuclear waste:

- More than half the EU's citizens oppose the use of nuclear power, according to a new Eurobarometer survey.
- A majority would instead support it if radioactive waste management issues could be solved.
- Of 25,000 EU citizens questioned this spring, 55% said they were "totally" or "fairly" opposed to nuclear power, while 37% were totally or fairly in favour.
- Support for nuclear would increase if the sector's waste problems were tackled, the survey found. Of those initially declaring opposition to nuclear energy, 38% said they would support it "if the issue of nuclear waste were resolved".
- Non-governmental organisations and independent scientists remain the most trusted sources of information on nuclear questions, and the nuclear industry itself the least trusted, but trust in governments and the media has also plummeted.[79]

Eurobarometer survey:
http://europa.eu.int/comm/energy/nuclear/waste/doc/2005_06_nucelar_waste_en.Pdf
and summary
http://europa.eu.int/comm/energy/nuclear/waste/doc/2005_06_nucelar_waste_resume_en.pdf.

Only 1 in 4 support new nuclear reactors in the UK

245. Only 25% of the British public support the building of new nuclear power stations according to a survey carried out by the Institution of Civil Engineers.

ICE Press Release 11th March 2005

[79] *Most EU citizens "opposed to nuclear power"* Environment Daily 1944, 20/09/05

http://www.ice.org.uk/news_events/newsdetail_ice.asp?PressID=272&NewsType=Press

Poll shows nuclear waste as key environmental issue for the public

246. A MORI poll for the nuclear waste agency, NIREX, shows that a key issue in the nuclear debate is the disposal of radioactive waste.

247. The public rates environmental factors as the most important to take account of in the decision of what energy sources to use - cost is secondary.

248. Radioactive waste does not come first in terms of overall concerns for the public: only 3% mention it spontaneously as an environmental issue that concerns them.

249. When prompted with a list of six major environmental and scientific issues, the public places the management of radioactive waste at the top of the list, alongside controlling pollution.

250. When asked how reliable and honest they expect a number of organisations to be in relation to giving information on radioactive waste, the public places the nuclear industry near the bottom; only the British Government is less trusted. The environmental campaign groups are the preferred option, followed by university/academic scientists.

MORI 2nd December 2004 http://www.mori.com/pubinfo/rk/what-do-the-polls-tell-us.shtml

The establishment of the Nuclear Decommissioning Authority (NDA) on 1st April 2005 has had little impact on public awareness.

A new MORI public opinion survey shows that building public confidence in the nuclear industry is still very much a live issue, and a challenge to the success of the NDA. Only four in 10 (38%) are very or fairly confident that the right decisions will be made regarding the future of the industry.

MORI 11th April 2005

http://www.mori.com/polls/2005/nda.shtml

73% of Scots support building more wind farms and only 17% the nuclear option.

According to a BBC poll. FoE Scotland Press Release 11th April 2005

http://www.foe-scotland.org.uk/press/pr20050405.html

BBC 11th April 2005

http://news.bbc.co.uk/1/hi/uk_politics/vote_2005/scotland/4430659.stm

More than half of UK public opposed to new nuclear stations

JUST over half of people were opposed to the Government considering nuclear power as a future energy source, according to a poll of 1,000 people for BBC 2's Newsnight. Only 39% were in favour.

BBC 16th May 2005: http://news.bbc.co.uk/1/hi/uk/4552051.stm

59% say it would be irresponsible to build more nuclear power stations while problems remain in disposing of nuclear waste.

THE public is sceptical about the case for building new nuclear power stations. Hostility to nuclear power is matched by a belief that renewable sources of energy such as wind

farms could fill the gap in energy needs in the next 20 years. A Populus survey also found that politicians are not trusted to tell the truth about nuclear safety. The poll found that 59 per cent of those questioned believe that it would be irresponsible to build more nuclear power stations while problems remain in disposing of nuclear waste. Half of respondents go so far as to say that they believe nuclear power to be unsafe.

Times 8th August 2005
http://www.timesonline.co.uk/article/0,,2-1726141,00.html

APPENDIX 1

HOUSE OF COMMONS ENVIRONMENTAL AUDIT COMMITTEE INQUIRY INTO:
Keeping the lights on: nuclear power, renewables and climate change

Segregated Decommissioning Funds

Introduction

251. In order to ensure that adequate funds exist for decommissioning a nuclear power station and managing the waste produced during its life, it is necessary for the owner to make regular contributions to a segregated fund from the start of reactor operations based on cost assumptions that err on the side of caution in order to minimise the risk of under-provisioning.

252. Failure to establish an adequate segregated fund could result in taxpayers being forced to fund liabilities accrued by a company which has made profits and paid shareholder dividends during the operation of its nuclear reactors. The lack of a legal requirement for a segregated fund in the UK will have implications for the public acceptability of new nuclear power stations. Conversely, investors may be more favourably disposed towards new build if they believe it is possible to reap profits without providing for the liabilities.

The Policy Framework

253. Under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Article 22), the states should be committed to ensuring that:

"… adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning"

254. In its report on compliance with the Convention the UK Government says its policy is that:

"*Cost implications should be brought home directly to the people responsible – the polluter pays principle"*[80].

255. Yet the Government has recently downgraded its commitment to the establishment of segregated funds from those contained in the 1995 "Review of Radioactive Waste Management Policy" [Cmnd 2919 paras 120-131]. The new policy statement on "*The Decommissioning of UK's Nuclear Industry's Facilities*" (Sept 2004) says the Government:-

"…expects that all operators will take the steps necessary to ensure that their decommissioning work is **adequately** funded". *[para 14] (emphasis added)*

[80] DEFRA (2003) *National Report on Compliance with the Obligations of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.*

256. The European Parliament (EP) has been pressing, for some time, for legislation to require nuclear operators to establish segregated decommissioning funds, but nothing with legal force has been agreed by the Commission.

British Energy

257. BE received several of its plants at discounted rates – a subsidy in itself – on the understanding it would cover liabilities, but it didn't.The original arrangements for British Energy's (BE's) nuclear decommissioning fund (NDF) were set out in the BE share prospectus when the Company was first privatised. The NDF, run by trustees, was to receive predetermined contributions from BE. The contributions were to be reassessed every five years in an attempt to ensure that there were adequate assets to meet BE's decommissioning liabilities. Despite this BE failed to make adequate provision to fund its liabilities.

258. The Department of Trade and Industry (DTI) was severely criticised by the National Audit Office (NAO) for its failure to identify the potential risks to the taxpayer caused by BE under-providing for its liabilities.[81] This raises serious questions about how the risks of future private nuclear operators will be monitored and – if necessary – controlled by the Government.

259. There are no legal mechanisms in place to ensure oversight of – and compliance with – Government policies on segregated funds by private nuclear companies. It is also debatable whether those that exist for Government owned commercial ventures such as BNFL are as stringent as Parliament would like.

260. Under BE's proposed restructuring plan announced on 28 November 2002, the Government will take on financial responsibility for around £3.3bn of nuclear liabilities (waste management & decommissioning costs). The NDF will be enlarged into a renamed Nuclear Liabilities Fund. The Secretary of State for Trade and Industry has agreed to fund additional liability costs to the extent that they exceed the assets of the NLF and, subject to certain exceptions (e.g. contracted liabilities for historic spent fuel are already covered by the restructuring agreement which came into force this year). There will also be new arrangements for the contribution of funds by BE to the NLF.

261. Section 7(2) of the Energy Act 2004 nominated the Nuclear Decommissioning Authority as an agent to perform certain functions assigned to it under the BE Restructuring Agreements. It will, for example, be responsible for oversight of BE's plans for decommissioning and for the discharge of certain nuclear liabilities.

Making Segregated Funds a Legal Requirement

262. It might have been expected that the Government would have ensured, through the Energy Act, that a British Energy-type shortfall in decommissioning funds could not recur by putting in place legislation which would require any

[81] NAO, 6/2/04 http://www.nao.gov.uk/publications/nao_reports/03-04/0304264.pdf

company that owns nuclear power stations to establish adequate segregated funds for their liabilities.

263. The House of Commons Trade and Industry Committee in discussing this matter did not go quite so far as to suggest a legal requirement but did recommend:-

"…a statement of policy by the DTI that approval of any proposal from the private sector for new nuclear plant would be conditional, amongst other factors, upon the establishment and maintenance of a segregated fund to meet the costs of clean-up at the end of its useful operational life." [82]

264. Unfortunately, because of the Government's desire to keep the Energy Act 'flexible' to allow for any future British-Energy-type crisis, a condition for segregated funds for future private nuclear operators has not been forthcoming. On 15 January 2004, Lord Whitty told the House of Lords (Column GC170) during a debate on the Energy Bill, that in principle the Government supports the idea that future nuclear operators should meet the costs of decommissioning, and the 'polluter pays principle', but:

"there may again be circumstances in which a private sector operator cannot meet its nuclear obligations … we must retain the possibility of the Government meeting such costs … in certain circumstances, it is inevitable that the operator will not have sufficient funds to cover those costs … Ultimately there may be some liability to be borne by government … using the NDA as a conduit or interface for any future British Energy-type crisis should not be prevented by this legislation".

265. It is staggering that due to the failure of adequate oversight by the DTI of BE, and the company's failure to have enough money for liabilities, that the Energy Act should now contain provisions that allow the Secretary of State to be able to direct the NDS to cover liabilities for future private operators of nuclear plants.

266. This has major implications for the potential viability of new nuclear power stations. Investors may be more favourably disposed towards new build because the Energy Act could enable owners of new nuclear stations to reap profits for directors and pay out to shareholders whilst under-providing for liabilities in the knowledge that, should these become unmanageable, there exists a mechanism to allow the Government to bail the company out.

Conclusion

267. The BE debacle shows that unless segregated decommissioning funds are made a legally binding requirement, there is still a significant risk future nuclear operators could under-provide in the full knowledge that Government will bail them out if they get into difficulty. Knowing that this is a possible course of action could make investors more likely to invest in new nuclear power stations than would otherwise have been the case, thus giving new nuclear stations an unfair competitive advantage over alternative sources of energy.

[82] Para 20. Trade and Industry Committee, The Nuclear Decommissioning Authority Pre–legislative Scrutiny of the Draft Nuclear Sites and Radioactive Substances Bill. Seventeenth Report of Session 2002–03.

Attachment with reference to TOR 4.2 of the Environmental Audit Committee:

Proliferation Issues

US hopes for nuclear energy face resistance

By Fiona Harvey, Environment Correspondent
September 19 2005 03:00

The US government has begun preparing the ground for a major expansion of civil nuclear power generation at home and abroad, but it faces serious problems and potentially stiff opposition in both aims.

Against the background of the continuing stand-off with Iran over its nuclear programme, Condoleezza Rice, the US secretary of state, chose to speak out strongly last week in favour of extending nuclear energy to developing countries as a way of easing the energy crisis and combating climate change.

Ms Rice told heads of state and business leaders at the Clinton Global Initiative in New York: "Civilian nuclear power is going to have to be part of the mix [in developing countries]." She asked: "How are we going to satisfy the extraordinary need for energy in really rapidly developing countries? I don't think solar and wind are going to do it. We are going to have to find a way to harness all energy supplies - that includes civilian nuclear power."

But early indications of the difficulty of the approach came from Kofi Annan, the United Nations secretary-general. He told the Clinton Global Initiative audience that one of his biggest regrets of the UN Summit was its failure to agree a solution to nuclear proliferation. He warned of the dangers that proliferation posed, in giving terrorists opportunities to steal nuclear products that they could use to make so-called "dirty" bombs, which would combine radioactive material with conventional explosives in order to make bombs that could spread harmful radioactivity over a wide area.

Bill Clinton, the former US president, agreed: "The push to bring back nuclear power as an antidote to global warming is a big problem. If you build more nuclear power plants we have toxic waste at least, bomb-making at worse.'

Timothy Wirth, the president of the UN Foundation, dismissed Ms Rice's arguments: "It sounds good if you say it fast enough."

The Bush administration has already made moves to open up a dialogue with India to help it develop civilian nuclear power plants. Separately, China has expressed an interest in building nuclear power plants of its own that would adopt a modern type believed to be safer than conventional designs.Amid signs of renewed interest in nuclear power, the UK government is preparing for the sale of Westinghouse Electric, the nuclear technology specialist owned by British Nuclear Fuels, the British state-owned nuclear energy company. Doosan Heavy Industries, a South Korean company, became the latest of a string of about 15 companies to express an interest in buying the company last month. Other interested parties include General Electric, Shaw of the US, Toshiba and Mitsubishi.

This month Areva of France joined forces with North American nuclear power producer Constellation Energy to get a head start in the race to build the first nuclear power reactor in the US in almost 30 years. Nuclear power is regarded by some as a solution to the problem of climate change as it does not emit carbon dioxide, produced by burning fossil fuels, which traps heat on Earth to cause global warming.However, environmental groups warn that the waste created by nuclear power plants poses a danger, as it remains radioactive for many thousands of years and is very difficult to store safely.

Nuclear Weapons in Iran: Plowshare or Sword?

May 25, 2004 New York Times

By WILLIAM J. BROAD

Recurring fear haunts the West's increasingly tense confrontation with Iran: Is its work on civilian nuclear power actually a ruse for making a deadly atomic arsenal, as has been the case with other countries?

Next month, the United Nations plans to take up that question at a board meeting of the International Atomic Energy Agency, in Vienna. The diplomatic backdrop includes possible sanctions and even the threat of war.

"If Iran goes nuclear, you worry that Hezbollah goes nuclear," said Paul Leventhal, president of the Nuclear Control Institute, a private group in Washington, referring to the Iran-backed terrorist group.

The Iranian crisis, and related ones simmering in North Korea and also around Dr. Abdul Qadeer Khan, the Pakistani expert who recently confessed to running nuclear black markets, are giving new urgency to limiting proliferation, a central danger of the atomic era. Recently, international inspectors discovered that North Korea may have clandestinely supplied uranium to Libya, demonstrating how an aspiring state can secretly reach for nuclear arms.

The development of such arsenals is often hard to hide, because it takes place in large industrial complexes where nuclear power and nuclear weapons are joined at the hip - using technologies that are often identical, or nearly so. Today, with what seems like relative ease, scientists can divert an ostensibly peaceful program to make not only electricity but also highly pure uranium or plutonium, both excellent bomb fuels.

Experts now talk frankly about a subject that was once taboo: "virtual" Weapon states - Japan, Germany, Belgium, Canada, Brazil, Kazakhstan, Taiwan and a dozen other countries that have mastered the basics of nuclear power and could, if they wanted, quickly cross the line to make nuclear arms, probably in a matter or months. Experts call it breakout.

The question now, driven largely by the perception that the world is entering a dangerous new phase of nuclear proliferation, is whether the two endeavors can be separated. And as difficult as that may seem, new initiatives are rising to meet the challenge.

Last year, North Korea stunned the world by withdrawing from the Nonproliferation Treaty. It was the first time a nation had dropped out of the 1968 pact, setting a grim precedent and prompting warnings of the accord's demise.

If another virtual power crosses the line, experts fear, it could start a chain reaction in which others feel they have no alternative but to do likewise.

Yet a country like Iran can retain its virtual-weapons status - and the threat of breakout - even if the International Atomic Energy Agency gives it a clean bill of health. That kind of quandary is driving the wider debate on ways to safeguard nuclear power, especially given that the world may rely on it increasingly as worries grow about global warming and oil shortages.

"We can't give absolute guarantees," said Graham Andrew, a senior scientist at the agency. "But there will be technological developments to make the fuel cycle more proliferation-resistant."

Other experts agree. "The future looks better than the past in terms of this whole problem," said Rose Gottemoeller, a senior associate at the Carnegie Endowment for International Peace. "At the moment, it's a very, very fast-moving arena that a lot of people are into and thinking about."

The central compact of the nuclear age - what critics call a deal with the devil - is that countries can get help from other nations in developing nuclear power if they pledge to renounce nuclear arms. That principle was codified in the 1968 treaty and has produced a vast apparatus of the International Atomic Energy Agency that not only helps nations go peacefully nuclear but also monitors them for cheating.

But surveillance has proved far from perfect, and states have proved far from trustworthy.

"If you look at every nation that's recently gone nuclear," said Mr. Leventhal of the Nuclear Control Institute, "they've done it through the civilian nuclear fuel cycle: Iraq, North Korea, India, Pakistan, South Africa. And now we're worried about Iran."

The moral, he added, is that atoms for peace can be "a shortcut to atoms for war."

Moreover, the raw material is growing. The world now has 440 commercial nuclear reactors and 31 more under construction.

Experts say Iran provides a good example of the breakout danger. With the right tweaks, its sprawling complex now under construction could make arms of devastating force. Recently, mistrust over that prospect soared when inspectors found that Iran had hidden some of its most sensitive nuclear work as long as 18 years.

In the central desert near Yazd, the country now mines uranium in shafts up to a fifth of a mile deep.

At Isfahan, anancient city that boasts a top research center, it is building a factory for converting the ore into uranium hexafluoride. When heated, the crystals turn into a gas ideal for processing to recover uranium's rare U-235 isotope, which, in bombs and reactors, easily splits in two to produce bursts of atomic energy.

Nearby at Natanz, Iran aims to feed the gas into 50,000 centrifuges - tall, thin machines that spin extraordinarily fast to separate the relatively light U-235 isotope from its heavier cousin, U-238. It recently came to light that Iran had gained much help in making its centrifuges from Dr. Khan and his secretive network.

Iran says it wants to enrich the uranium to about 5 percent U-235, the level needed for nuclear reactors.

But enrichment is one place that good power programs can easily go bad, nonproliferation experts say. By simply lengthening the spin cycle, a nation can enrich the uranium up to 90 percent U-235, the high purity usually preferred for bombs.

Moreover, a dirty little secret of the atomic world is that the hardest step is enriching uranium for reactors, not bombs. David Albright, president of the Institute for Science and International Security, an arms control group in Washington, said the step from reactor to weapon fuel took roughly 25 percent more effort.

The whirling centrifuges at Natanz could make fuel for up to 20 nuclear weapons every year, according to the Carnegie Endowment. Others put the figure at 25 bombs a year. The Iranians are building a large power reactor at Bushehr on the Persian Gulf meant to be fueled with low-enriched uranium from Natanz. Here too, experts say, a good program can go bad.

Normally, uranium fuel stays in a reactor for three or four years and, as an inadvertent byproduct of atomic fission, becomes slowly riddled with plutonium 239, the other good material for making atom bombs. But the spent fuel also accumulates plutonium 240, which is so radioactive that it can be very difficult to turn into weapons.

But if the reactor's fuel is changed frequently - every few months - that cuts the P-240 to preferable levels for building an arsenal. (And since less plutonium than uranium is needed for a blast of equal size, it is the preferred material for making compact warheads that are relatively easy to fit on missiles.)

John R. Bolton, the State Department's under secretary for arms control, recently told Congress that after several years of operation, Bushehr could make enough plutonium for more than 80 nuclear weapons.

Iran strongly denies such ambitions.

"That we are on the verge of a nuclear breakthrough is true," Hashemi Rafsanjani, Iran's former president, said recently, according to the Islamic Republic News Agency. "But we are not seeking nuclear weapons."

If Iran wanted to recover plutonium from Bushehr, or a different reactor under construction at Arak, it would have to extract the metal from spent fuel, a hard job beause of the waste's high radioactivity. Such reprocessing plants have legitimate commercial uses for turning nuclear detritus into new fuel, as France, Britain, Japan and Russia do.

Iran, too, has announced that it wants to master the complete nuclear fuel cycle, apparently including reprocessing. Last year, President Mohammad Khatami said the country wanted to recycle power-plant fuel. "We are determined," he said in a televised speech, "to use nuclear technology for civilian purposes."

Around the globe, experts are struggling to find ways to guarantee such good intentions: not just in Iran, but everywhere.

Mohamed ElBaradei, director of the International Atomic Energy Agency, is calling for "multinational controls" on the production of any material that can be used for nuclear arms. If accepted, that would mean no single country could enrich uranium or reprocess plutonium on its own, but only in groups where members would verify each other's honesty.

Early this month, Iran signaled that it might be interested in teaming with Russia and Europe to enrich uranium, giving arms controllers some hope of a peaceful resolution to the current crisis.

Matthew Bunn, a nuclear expert at the Kennedy School of Government at Harvard, has called for sweetening the deal by guaranteeing members of a consortium lifetime fuel supplies and spent-fuel removal if they forgo enrichment and reprocessing plants.

"What you need is an incentive," he said. One challenge, he added, would be convincing states that consortiums "won't change their minds," given that nuclear policy makers have often done so in the past.

President Bush has taken a harder line, proposing in a February speech to limit drastically the number of nations allowed to produce nuclear fuel. Only states that already have enrichment and reprocessing plants, he said, should do such work, and they in turn would service countries that aspire to nuclear power.

While many experts praise Mr. Bush's attention to the nonproliferation issue, some have faulted his specifics. "It's all sticks and no carrots," said Mr. Bunn, adding that the Bush plan would only feed global resentment toward the nuclear club. "I think you can couch this to be more carrotlike."

Down the road, a different approach involves developing new classes of reactors that would better resist nuclear proliferation, especially by making the recovery of plutonium 239 much harder. Many studies, including one last year at M.I.T., have championed better fuel cycles and security.

"There is potentially a pathway - diplomatic, technical - to see a significant global deployment" of safer technologies and strategies, said Ernest J. Moniz, a former Energy Department official who helped lead the M.I.T. study. "But it can't happen without U.S. leadership and the U.S. partnering with other countries, and that will require a re-examination of our policies."

Mr. Leventhal of the Nuclear Control Institute said too many of the proposals were too timid. Most fundamentally, he said, nations have to turn away from the commercial use of plutonium, which grows more abundant every day.

"Only denial and greed" can explain the world's continuing to want plutonium for peaceful uses, he said, and added, "It may take the unthinkable happening before the political process can screw up the courage to put an end to this ridiculously dangerous industry."

Nuclear double standard

Why should some nations but not others be allowed nuclear weapons, asks Mohamed ElBaradei, director general of the International Atomic Energy Agency

New Scientist, p 17, 10 July 2004

During the cold war, global security depended on a nuclear stand-off between two broad alliances, NATO and the Warsaw Pact. It was based on the rather morbid doctrine of mutually assured destruction. As alliances leaders, the Soviet Union and the US protected and managed their respective spheres of influence and were able to minimise the nuclear of nations acquiring nuclear weapons.

In the past 15 years, the international security landscape has changed. The cold war rivalry disappeared. But rather than the much vaunted “new world order”, this has resulted in a sort of “new world instability.” Ethnic and religious tensions have erupted, while many regional conflicts such as that in the Middle East have continued to fester.

Rather than trying to understand these changes and adapting to the new threats, the international community has inclined towards inaction or unilateral “self-help” solutions. Against this backdrop of insecurity, we should not be surprised that some countries have continued to show an interest in acquiring weapons of mass destruction. Four undeclared nuclear programmes, in Iraq, Iran, Libya, and North Korea have come to light since the early 1990s.

We at the IAEA have learned valuable lessons from our recent experience in verifying these undeclared nuclear programmes. Perhaps the most important is that verification and diplomacy, used together, can work.

The Iraq experience demonstrated that inspections can be effective even then the country being inspected is less than cooperative. All the evidence indicates that Iraq’s nuclear weapons programme had been effectively dismantled in the 1990s through

IAEA inspection, as we were nearly ready to conclude before the war. Inspections in Iran over the past year have also been key to uncovering a nuclear programme that had remained hidden since the 1980s.

Perhaps the most disturbing lesson to emerge from our work in Iran and Libya is the existence of an extensive illicit market for nuclear items.

The ease with which Pakistan nuclear engineer Abdul Qadeer Khan and his associates were able to operate a multinational network clearly demonstrates the inadequacy of the present export control system.

It should be clear that we are well beyond the point where a few quick fixes will adequately address the new threats. But I find it encouraging that both governments and civil society are beginning to come forward with suggestions for dealing with them. My proposals fall into three areas.

The first concerns strengthened non-proliferation controls over the export of sensitive nuclear materials and technology. The nuclear export control system should be binding rather than voluntary, and should include all countries with the capability for manufacturing sensitive nuclear related items. We should consider limitations on the production of nuclear material through reprocessing and enrichment, possibly by bringing these operations exclusively under multinational control, while guaranteeing the supply of fuel to legitimate users. A multinational approach could also be applied to the management and disposal of spent nuclear fuel.

We should work to prevent the use of weapon-usable material in civilian nuclear programmes, and eliminate stocks of weapons-usable nuclear materials now in existence.

My second set of proposals involves strengthening the commitment of all states to nuclear non-proliferation and disarmament measures, including for example, the establishment of a concrete roadmap for verified, irreversible nuclear disarmament. It is 30 years since the enactment of the Treaty on the Non-Proliferation of Nuclear Weapons, and yet 30,000 nuclear weapons are still available for use.

In July 1996, the International Court of Justice (IJC) declared unanimously that nuclear states were obliged to conclude negotiations for “nuclear disarmament in all its aspects”. To my mind, it is hard to reconcile the opinion of the ICJ with the decision by the US to explore new types of nuclear weapons. More importantly, if this type of research proceeds, it is hard to see how we can ask the nuclear “have-nots” to accept the additional non-proliferation obligations and to renounce any sensitive nuclear capability as being adverse to their security.

My third set of proposals involves establishing a functional system for collective international security. The UN Security Council must be able and ready to engage effectively in both preventive diplomacy and enforcement measures. We must also work to address the root causes of insecurity and instability, including the widening divide between rich and poor and the chronic lack of good governance.

We have two possible courses of action. We can wait for the unthinkable to happen, or we can take notice of the writing on the wall and act today.

I repeat that is it time to abandon the unworkable notion that it is morally reprehensible for some countries to pursue nuclear weapons, but morally acceptable for others to rely on them.

This article is derived from a speech delivered at the Carnegie International Non-Proliferation Conference in Washington DC last month.