DRAFT

Reactor Decommissioning

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Context

Government perspective:

1 In line with the polluter-pays principle, any private sector consortium undertaking the building a new nuclear reactor ("NNB") would be required to meet the full costs of its subsequent decommissioning, irrespective of the costs of doing so. This is consistent with the treatment of other production facilities, such as coal-fired plant, and oil assets in the North Sea.

2 However, given the particular features of the nuclear industry, there is a risk that an owner/operator may experience circumstances in which it is unable to meet the costs of decommissioning the nuclear plant, not least as the cash outflows involved occur over many decades following the end of the revenue generating life of the asset itself.

3 Such a situation may arise where, for example:

- there is a material shortfall in funds available to the owner at the end of the asset's life compared to the then assessed costs of decommissioning;
- the operational life of the reactor ends earlier than had been expected (for example as a result of an accident, type fault or operational decision reflecting market conditions), and the owner has been unable to accumulate sufficient resources from its shortened operational life to fund the now much earlier decommissioning costs; or
- withdrawal or loss of support or other collateral provided by parent company. or other guarantor, that had been pledged to meet the costs of decommissioning.

4 In these, or equivalent, circumstances, Government would come under political and moral pressure to meet the unfunded costs of decommissioning if no alternative means of funding was available to the owner/operator.

5 A key concern for Government is therefore the need to prevent NNB projects progressing which fail to plan to make adequate provision for the end-of-life costs, and which increase the risk of reliance being placed on the tax payer as default insurer for the costs of decommissioning.

Owner/operator perspective:

6 At the point of commissioning of a new reactor the owner/operator will also assume the responsibility and financial liability for eventual decommissioning.

7 In an accounting sense, UK and International accounting standards will require that the Net Present Value ("NPV") of the expected future cash outflows on decommissioning be capitalised as part of the balance sheet cost of the asset at the point of commissioning, with an equivalent provision being established as a liability on the balance sheet for the same.

8 As the uplifted cost of the asset is then depreciated over its useful life, and the value of the decommissioning provision re-assessed each year, the effect is to ensure that the profit and loss account suffers an annual charge to reflect that year's proportionate share of the expected future cost.

9 However, this accounting treatment does not have any impact on cash – the cash required to actually pay for the decommissioning activities is assumed to be available at the time required, and it is a matter for the owner/operator to ensure that those funds are available at the time.

10 From a decommissioning perspective, an owner/operator considering whether to build and/or finance a NNB will be making a binary decision, at a point in time, taking into account factors such as:

- the degree of certainty as to what risk or liability it is assuming (the scope of the liability - what does decommissioning include and exclude?);
- the robustness of the cost estimates, including an assessment of the numerous assumptions regarding future price levels, the extent of contingency provided, relevant recent experience etc;
- the risk that regulatory or statutory change will occur after the commitment is irrevocably made, resulting in changes to the decommissioning scope or methodology, and so materially worsening the project economics; or
- the availability and cost of risk-mitigating instruments (insurance, regulatory risk insurance, hedge instruments, letters of credit, etc).

Description of decommissioning

11 As summarised in the British Nuclear Group's Lifecycle baseline documents (2004) for the Magnox reactors, decommissioning is the set of activities undertaken at the end of a nuclear facility's operational life to take it permanently out of service with adequate regard for the health and safety of workers, the public and the protection of the environment, and achieves the agreed or assumed end state for the facilities and site.

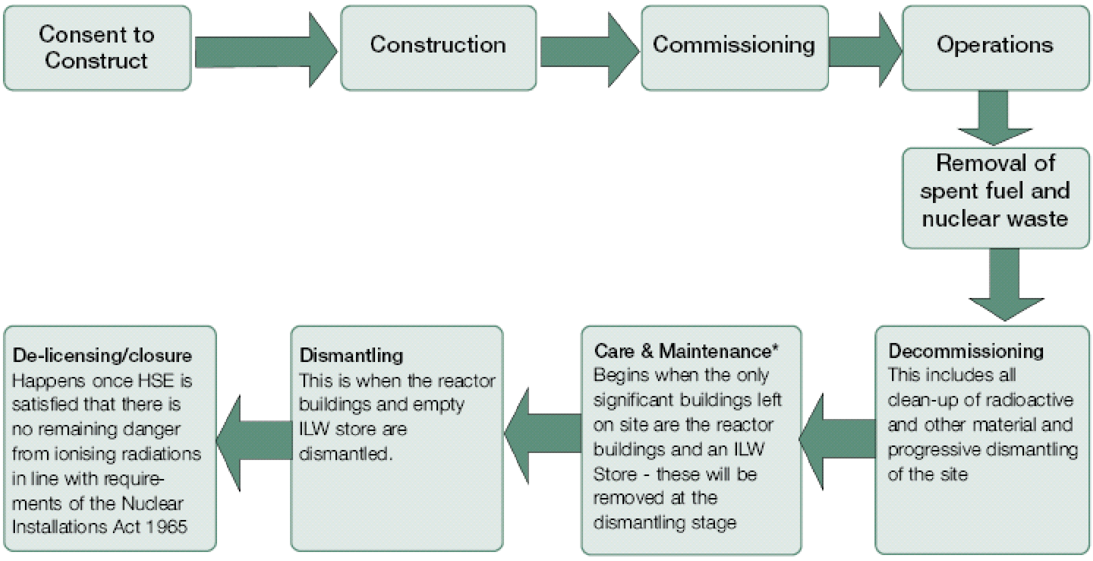
12 In 1999, the International Atomic Energy Agency ("IAEA") defined three stages of decommissioning, with the following broad characteristics:

Stage 1	shutdown of the plant, fuel removal, draining of circuits (>99% of radioactivity removed, dismantling of non-nuclear facilities. Reactor containment maintained, with controlled access.
Stage 2	dismantling of remaining non-nuclear buildings, and those nuclear buildings excluding the reactor buildings, evacuation of wastes to storage facilities, ongoing containment and surveillance of the reactor core and buildings, though usually requiring reduced ventilation, surveillance etc.
Stage 3	all materials, equipment and structures in which radioactivity levels exist above prescribed limits removed. Site released for alternative use - no radiological restrictions

13 The IAEA has subsequently developed its definition further, reflecting five Phases: Operational; Shut-down transition; Preparation for safe enclosure; Safe enclosure; and Final dismantling

14 The precise approach to the decommissioning activity in the UK depends upon the nature of the reactor itself, but also on the strategy agreed with the Nuclear Installations Inspectorate ("NII") - particularly with respect to the chosen end-date for return to alternative use, and whether a care and maintenance phase is planned.

15 The diagram below from the NDA draft strategy for consultation, (2005), summarises the typical stages:



16 One of the key differences between alternate proposed decommissioning strategies is whether a period of safe enclosure is anticipated, and to a

lesser extent, what periods of care and maintenance are assumed between other elements of the decommissioning activities.

17 Safe enclosure involves the physical encapsulation of the reactor buildings (once reduced as far as is practical) within a new containment structure, potentially for several decades. Throughout this period only limited security and monitoring costs are incurred, so significantly deferring the point when the containment, reactor buildings and core are dismantled.

18 Care and maintenance periods may exist between major tranches of work, but are likely to be relatively short periods in which the site is left in a passive state, but without construction of new containment structures. The ongoing costs of security, monitoring etc are likely to be higher than during enclosure, and the deferral before further decommissioning activity shorter.

19 There is an ever-evolving view of the optimal approach to the decommissioning of the UK's legacy reactors, in part driven by changes in perceived strategic imperatives. The NDA's latest consultation is seeking agreement to prompt decommissioning, returning the whole of a Magnox reactor site to alternative use within 25 years, but this increases the NPV of the costs incurred when compared to both the previous BNFL/Magnox strategy of long term Care and Maintenance, as agreed in the 5 yearly QQR process, and the alternative proposed by BNG's Magnox Innovation programme.

20 The anticipated advantages of a more rapid decommissioning process are expressed by the NDA as:

- improving confidence and experience of the technology and cost estimates;
- earlier return to alternative use of the sites;
- potentially less transient ILW storage; and
- better use of a near–term skilled workforce.

21 However, a more rapid approach (and the benefits yielded) may also present greater risk, and therefore potentially greater cost, than would otherwise be necessary. Issues include:

- dealing with a higher level of radiological contamination, hence greater dosage to workers, and more costly techniques required, such as remote handling;
- risk that technology solutions assumed are either not developed, are unsuccessful, or create further unanticipated costs when applied;

- mistakes, failed approaches, inefficient spend etc will have a much higher NPV impact as the spend, and potential additional costs, will all be incurred much nearer-term.

22 The assessment of which approach is optimal requires the identification and weighting of several diverse factors (safety, cost, availability of waste routes etc). Prior to the NDA's more recent proposals, the UK's approach has generally been to weigh the potential safety and radiological dosage risks highly, and has lead to the development of safe-store and other deferred strategies.

23 Experience in the US and elsewhere suggests that complete decommissioning can be achieved relatively quickly, in some cases as fast as 7 years. However, in a commercial context, operators are tending towards a range of 20 - 30 years, with the underlying assumptions for the EPR and AP1000 seemingly (but not definitively) expecting a 25 year timescale.

Costs of decommissioning

24 The majority of reactors presently in some stage of decommissioning, and therefore for which engineering and cost experience is being gained, are neither of the type or design that would be considered for NNB, and have usually formed part of a public construction and operation programme at a time when decommissioning requirements were not primary concerns.

25 Equally, the experience being gained with early stage or pilot decommissioning is informing currently proposed designs, and giving rise to more assertive assurances from vendors that designs are mindful of end-of-life costs.

26 Reliable and relevant information on the actual costs of decommissioning reactors is limited, but growing. Generally the information that is available is subject to a wide range of uncertainties, assumptions, strategies and money values, and relates to a wide range of reactor types and issues. Consequently caution is required in drawing conclusions from the cost estimates, particularly as they might relate to the actual costs of decommissioning future reactors built.

27 Appendix A contains a summary of recent evidence or published reports as to actual or estimated decommissioning costs. Bayliss and Langley, UKAEA (2003), note that "there is an increasing cost trend over time for reactor decommissioning associated with increasing waste disposal costs."

28 Whilst acknowledging the lack of direct comparability with potential new reactor designs, there is a tendency in the cost estimates for existing Light Water Reactors (and hence ignoring the UK Magnox and AGR fleets)

towards a cost range of £300m - £420m per installed 1,000MW, broadly expressed in 2006 money values.

29 The distribution of potential outcomes around this estimated central range is unlikely to be even, with the prospect of these costs being lower limited, whilst higher out-turns are more likely.

Issues that complicate direct comparison of cost estimates

30 Aside from the major differences in costs caused by the inherent design and technology differences between reactor types, a number of other factors also have a bearing on the comparability of cost estimates, and equally on an understanding of future cost projections.

31 Recognition of these factors is important, as many of the publicly quoted estimates do not provide specific information on assumptions made in these respects. Relevant factors could include any or all of the following:

Money values	in which year's money values are the costs expressed?
Contingencies	to what extent have contingencies been included in the cost estimates, and which risks are they intended to cover?
Scope	what specific steps, activities and costs are included/excluded from scope?
End status	what is the assumed condition of the site at the end of the decommissioning process, de-licensed, green-field, new nuclear use?
Waste	do waste disposal routes exist, and are treatment and conditioning costs known? What is the boundary between costs related to waste, and those relating to decommissioning?
Strategy	more rapid decommissioning is likely to be more expensive in NPV terms (requiring more remote handling, in higher dosage environments etc). Conversely, more extended care and maintenance phases may reduce NPV, whilst increasing absolute spend over time
Administration	are costs of relating to the regulatory environment included, such as site services, programme management, security etc?
Discounting	what discount rates have been applied to future cash flows?
Escalation	have current cost estimates been subject to prudent price escalation prior to being discounted?

Decommissioning cost estimates are susceptible to increase over time

32 Whilst a cost estimate may be made on the basis of the best available information, experience and expectations at the time of commissioning, there remain a number of risks that the cost estimate will be inadequate when compared to the actual out-turn cost estimate at the end of the station's operational life, and indeed the final costs of actually executing the decommissioning work:

(a) Estimating errors arising from:

- vendor optimism
- relevant price index increases being higher than expected (labour, pensions costs, materials etc)
- incomplete or inaccurate assumptions

(b) Regulatory changes
Whilst the decommissioning strategy and cost estimate can be established at the point of commissioning, nuclear stations are subject to continuous monitoring and regulation throughout their life, and there is a very high probability that the NII, HSE or other statutory or legislative changes will add to or amend the basis on which the decommissioning strategy must be executed, with a consequent increase in costs.

(c) Operational behaviours
Reflecting the risk that future operational behaviours, procedures or practices increase the extent or significance of contamination, or give rise to more complex and costly decommissioning requirements

33 Of these, (a) would usually be accommodated by including contingency within the cost estimate, but also through the escalation of the cost estimate (in today's money values) to reflect anticipated future price index rises, before discounting the up-lifted cost estimate back to today's NPV.

34 Example, taken from DTI model, for a 1,600MW EPR reactor:

Cost of decommissioning (2006 mv)	£500m	cost if done today
Escalated to end of life in 2046 (2006 mv)	£1,300m	likely cost in 2046, in today's money values, all other things being equal
NPV at start of life (2006 mv)	£65m	liability on balance sheet at start of life

35 Neither (b) nor (c) can be (or are likely to be) predicted at the point of commissioning, but experience suggests that both will occur through a station's operational life. Whilst (c) is within the control of the owner/operator, and should act as an incentive to avoid practices and behaviours that serve to increase the liability to be borne by the owner, (b) is largely outside the owner's control, and represents a potentially material uncertainty to a proposed NNB.

Decommissioning costs are largely unavoidable once operation starts

36 Once the core has been irradiated, the costs of decommissioning a nuclear reactor are largely fixed, and are entirely unavoidable. Whilst other issues (such as declining standards in operation or integrity) may cause some

increase in aggregate costs, the broad level of decommissioning cost would be expected to remain broadly constant throughout its operation, all other things being equal.

37 Consequently, the latent liability and exposure for the costs of decommissioning exist fully on the first day of operation, even though, in the normal course of events, the NPV of the future liability will increase over time only slowly, building up to the eventual estimated cost as the effect of discounting unwinds.

Responsibility for decommissioning at end of anticipated life

38 Whilst the assumption is that the polluter-pays principle is to be applied, the question of whether the polluter should also be responsible for the execution of the decommissioning activity is less clear.

39 There are a number of factors that would suggest that the owner/operator may not be best placed to undertake the decommissioning activity:

- the work will take place in the post-operational period, which in the event of a consortium or single project company would require the company (and it's equity sponsors) to remain active for many decades after revenues have ceased to be earned;
- the core skills required, project management experience and ability to deliver activity at optimal cost may sit elsewhere, with the NDA (or its equivalent), and the contractor base developed by the NDA;
- such an approach may increase total costs of the activity, particularly regarding contractual and regulatory interfaces for both the owner/operator and the regulatory and contracting bodies;
- incorporating a given incremental nuclear reactor's decommissioning into a wider, centrally controlled programme is likely to enable more cost effective delivery of the totality of the UK's liabilities.

40 At present, a developer of an NNB would have to assume that it would be responsible for the execution of all decommissioning activities. Subject to the following sections on funding decommissioning costs, there would appear to be merit in defining more clearly:

- whether the responsibility for decommissioning may be transferred to another body, such as the NDA;
- if so, at what point this transfer would occur (and with what conditions);
- whether the owner/operator's liability is fixed at this point, with all up-side/down-side taken by the newly responsible party

41 In this regard, the impact of the NDA's recent announcements that in the two years since its assumption of responsibility for the UK's decommissioning and waste liabilities, the undiscounted aggregate cost estimate has risen by some 45% from £48bn to £70bn by 31st March 2006 will not give potential developers or financiers confidence that current estimates of decommissioning costs for new reactors will not be susceptible to the same degree of inflation as their incidence becomes closer, or the NDA assumes responsibility for them.

Funding of the decommissioning liability

42 Based on the foregoing sections, there are three key issues to be addressed when considering the funding of the decommissioning liabilities:

(a) how to ensure the owner/operator has provided sufficient cash resources to meet the liability at the expected end of life [paragraphs 46 – 69];

(b) how to meet the costs of earlier decommissioning in the event that the plant is unable to achieve it's expected lifetime, and insufficient funds are available to the operator life [paragraphs 70 - 84]; and

(c) how to apportion the risk that decommissioning costs may vary (upwards) as a result of regulatory changes throughout the NNB's lifetime. [paragraphs 85 – 90]

43 A separate, but intrinsically linked, issue is the extent to which the Government may explicitly assume some element of the liability, and the point in time at which such assumption of liability may occur.

44 For the remainder of this paper, the assumption is made that Government does not assume any liability throughout the reactors' operational lives, other than the moral and political obligation to step in as insurer of last resort, which remains with it today. However, it is assumed that the NDA, or an equivalent Government Agency, will assume responsibility for and control of the decommissioning process, and any accumulated funds, at a defined point at the end of the reactors' operational lives (potentially after de-fuelling is complete).

45 Consequently, taking each of the above three issues in turn:

Funding of the liability at end of normal life

46 The key concern from Government's perspective is to ensure that the operator is making adequate provision throughout the operational life of the station to meet the decommissioning cash outflows (as opposed to merely making adequate accounting provision).

47 In general, proposals that would serve to mitigate the risk to Government (the separate identification and segregation of cash) would also serve to impair, relatively, the economics or risk profile from the developer's perspective, but may also provide some comfort to the NNB project's other stakeholders.

48 <u>Two options are:</u>

- Cash endowment at start of life, funded as part of the total capital cost of the project, and held in a segregated fund (either within or outside the company).

  The quantum of cash balance required would be scaled to reflect the cash at the point of commissioning, which when invested over planned operational life, would be expected to grow to equate to the NPV of the future decommissioning cash outflows at the end of operational life. Such an endowment would be likely to represent in excess of 10% of the capital cost of the construction.

- Requirement for the operator to transfer cash to an accreting fund (whether held within or outside the project itself). The basis for the determination of the annual amount required would be established at the point of commissioning.

<u>What level of funding would be required?</u>

49 Taking the EPR case from the DTI model, and assuming that the decommissioning cost remains at £500m (in 2006 mv), investment returns are 2%, and the station's operational life is 40 years, the funding in the two options above would be:

Cash endowment:	£230m
Annual funding (flat):	£8.25m per annum

<u>Detailed application issues</u>

50 In considering these basic options, there are a number of specific issues relating to the operability of such a mechanism that require more detailed consultation and consideration:

Legal mechanism to be used to mandate the funding, and to protect the cash in the fund

51 How would the obligation be manifested? This may possibly be achieved through a number of different routes: a regulatory condition as part of the NII licensing process; as part of the Section 36 approval process; as part of the generating license conditions; or through some other, newly created contract or instrument.

52 In each case, the precise mechanism would require further investigation to establish its robustness, and may require primary legislation to achieve its purpose.

53 Irrespective of statutory or regulatory obligations, cash will only be protected operationally within a company if controls are in place to manage its disposition, with separation of responsibility from the company's management.

54 This may be achievable through the appointment of Independent Trustees, but whilst the cash is held within the company, its directors will continue to have legal obligations as to their fiduciary duties, and may not be able to cede discretionary responsibility to such trustees. This may therefore require the transfer of the funds into a separate trust (which could be operated on a singular or mutual basis for other projects).

55 To be protected in the event of an insolvency of the company, the funds would have to fall outside of the very wide definition of property in the Insolvency Act 1986. Trustee arrangements may achieve this, and whilst similar arrangements are minded for the petrol and offshore wind industries, these regimes are underpinned by the Petroleum Act 1980 and the Energy Act 2004.

Investment rules, hedging instruments

56 In cases where the funds are held within the project, whether separately or on a consolidated basis, there is a risk that if strict rules and controls are not applied for the investment of those cash funds higher risk investments may be made by the project owner in order to maximise potential growth, but in so doing, put at risk the capital sum itself, and hence the purpose of the imposition of the funding obligation.

57 May require explicit investment criteria and rules, with the consequent need for monitoring, either annually for compliance, or actively to prevent unapproved investments occurring.

It may be possible to design a self-regulating mechanism that also encourages a reasonable mix of risk and security, for example through allowing broader range of investments, but requiring that any funding deficits at the end of each year be made good in additional cash funding. This is closer to a defined benefit pensions model, but would also bring similar risks (of fluctuating investment performance, coupled with material increases to funding requirements, in many cases leading to financial inability to continue with the funding).

Re-assessment of liability through life, and hence the recalculation of the forward funding requirement

58 Leaving aside the regulatory risk issue (ie, that decommissioning costs will increase over time as the regulatory environment imposes differing strategies, or more costly approaches), there is a strong probability, based on past experience, that initial cost estimates (including contingencies) will increase over time.

59 Assuming that the owner retains the risk of such cost increases through operational life, there will need to be a pre-agreed mechanism in place to agree when such cost estimate increases have occurred, and what their quantum is. This will then need to feed into a revised annual funding obligation (though as a station approaches the end of it's life, the effect of recovering any cumulative under-funding from remaining years' cash flows will become proportionately more significant.)

60 For example, assuming an initial estimate of £500m which increases to £600m at year 20, and £750m at year 30 (in all cases in 2006mv, with 2% investment return and 40 year life), the annual funding obligation would be:

Years 1 – 20	£8.25m per annum
Years 20 – 35	£12.5m per annum
Years 35 – 40	£41.0m per annum

61 An alternative approach is to increase the amount of the flat annual obligation by a premia to reflect the transfer of that risk to another party (Government). It is likely that a potential NNB project will only be able to accommodate a higher level of funding obligation in situations where that additional cost is being incurred in return for reduced risk to the project itself.

Default provisions – what sanctions are minded in event that operator fails to make required funding?

62 There is a risk that an operator will fail to make its annual funding payment, or may breach some other obligation, for example by misapplying some of the accumulated funds.

63 In such an event Government would require some form of default provision (such as a 'cure' period, followed by a more tangible sanction). Such sanction may depend on the route through which the funding obligation was imposed, but may include removal of the NII license to operate, of the generation licence, or for the calling of some form of collateral or guarantee – see sections below).

64 As a default of this nature is more likely to occur where the project is in financial difficulty, it is arguable whether the sanctions would have any impact, other than to advance an inevitable administration, and bring about the crystallisation of the decommissioning risk for Government.

Operational responsibility/hand-over to NDA

65 Whilst the imposition of a funding obligation on a project will serve to mitigate risk to Government, it would also be expected to add incremental risk to a project's funding structure, and may also marginally increase the cost of debt raised.

66 As a quid pro quo for this additional burden, Government may consider what can be done to mitigate risk and uncertainty for a given project, and as discussed in paragraphs 38 - 41, this may be in the form of assuming the responsibility (and any further upside and downside risk) for decommissioning once an agreed state of post operational closure has been reached.

67 The NDA can only be given responsibility for decommissioning by way of a direction by the Secretary of State. A direction can only be given for non-publicly owned sites if the entity with control of the sites consents to it. To date, any designation has been accompanied by the transfer of property, rights and liabilities of the operator to the NDA so that the NDA can then competitively let contracts for decommissioning. The NDA does not become the site licence holder.

68 The table on the next page sets out certain other, more detailed, issues that may arise within a given project with a segregated funding option, and which may impact the project's NPV.

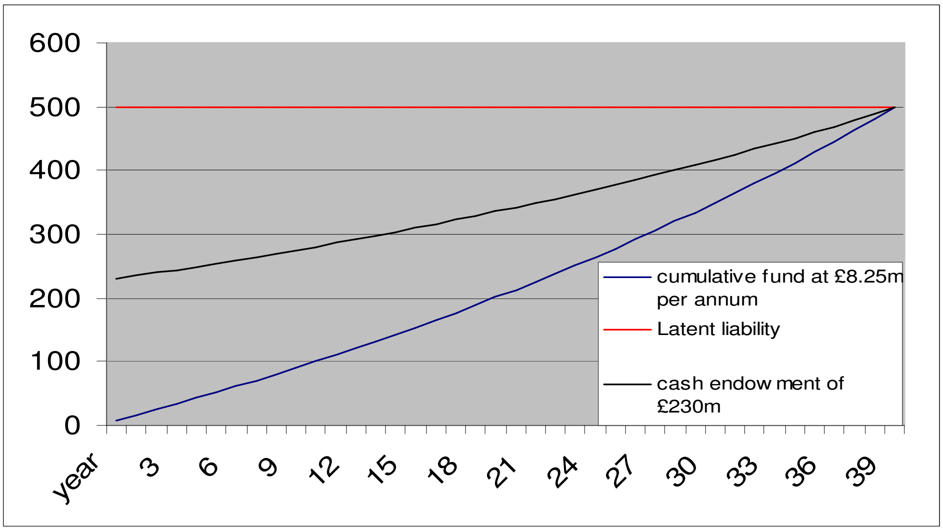
Other possible issues relating to application of a decommissioning funding obligation

Issue	Potential impact	Possible next steps
Requirement for a segregated cash fund will top-slice available operational cash flows through project life.	Pricing (interest rate margin) of debt tends to rise as the expected headroom within forecast free cash flows declines.	Whether this risk would materialise, and to what extent, should be tested with potential providers of debt finance, and the sensitivity to quantum of funding assessed.
	As the anticipated free cash flows are reduced, debt providers may assess the risk of default by the project as increasing. Debt providers are likely therefore to set more challenging debt covenants and ratios that enable them to protect their position in the event that the project's ability to meet principal and interest repayments is put at risk.	Whether this risk would materialise, and to what extent, should be tested with potential providers of debt finance, and the sensitivity to quantum of funding obligation assessed.
Taxation treatment of funding obligation held within the project may be neither optimal nor clear.	Income returns on the investment of the fund (if held within the project) would be expected to be liable to tax. Further, if funds are limited to no, or low, risk investment categories, return is likely to be low, and probably lower than the after-tax cost of debt carried to enable the fund to be built.	This is a matter for the potential NNB developers, however the potential impact should be evaluated to determine whether it may have an impact on the levelised costs of generation
	It is possible that an obligation to pay into a fund could also be said to amount to a "tax" on operators. Any taxation can only be imposed by Parliament, that is, through primary legislation.	Issue should be discussed with the Inland Revenue, and potential opportunities for clarifying and improving treatment investigated.
	As with the current situation, tax deductions will be available during the operational life of the reactor for only very limited elements of the accounting provisions made for decommissioning (the issue of "tax nothings"). The majority of decommissioning costs attract no deduction for tax.	Issue should be discussed with the Inland Revenue, and potential opportunities for clarifying and improving treatment investigated.
Taxation treatment of funding obligation payments made to a third party.	If funding obligation payments are made external to the project, and are a statutory or regulatory requirement to trade as a nuclear generator, there is a strong argument for those payments to be tax deductible when made. This could represent a potential additional value to a project.	Issue should be discussed with the Inland Revenue, and the potential to create tax-deductible (and hence valuable) payments through the operational life investigated. This may be possible (for example) if payments were made to a Government owned, Guernsey registered, mutual entity, which carried the net liability in return for the funding obligation payments. May also require specific reference in future Finance Bill.

Funding early decommissioning

69 As discussed in paragraphs 36 - 37, there is a latent liability for decommissioning from the moment that the reactor core is irradiated, and this liability remains largely constant throughout the station's operational life, ceterus paribus.

70 Assuming that a given project is meeting its obligations to accrete a segregated cash fund out of operational cash flows, it is only at the point of station closure that the cumulative fund will have reached a level to just meet the expected liabilities.



71 In the event that the station was to require decommissioning prior to the end of the anticipated operational life, the owner/operator would be faced with a shortfall in the accumulated fund, compared with the latent decommissioning liability at that point. The shortfall would be larger in the early years of operation.

72 Whilst it is possible that the project would have access to adequate cash resources to meet the brought forward liability (particularly if the project is one operated by a major group), this can not be assumed to be the case, particularly if the reason for the early decommissioning arises from an accident, financial default of the project itself, or regulatory imposed closure, for example where a type-fault emerges prejudicing the safe and economic operation of the plant.

73 As this latent liability is likely to be judged to be remote (although possible), it would be unlikely to be economically efficient to further increase the cash

burden on the project, however, alternative types of instrument may be capable of meeting the gap in funding, were such an eventuality to occur.

74 Whether these instruments will be made available, and on terms which are commercially viable, is a matter for more detailed investigation, and will depend on the perceived trade-off between the risk of the event occurring (and the obligation to pay the cash, and at what amount), and the premium that can be afforded. In each case the instrument is likely to have some form of annual renewal mechanism, and cannot be assumed to be available, at pre-determined cost, for an extended period.

75 Potential instruments include:

Letters of Credit

76 A Letter of Credit is a binding document issued by a bank on behalf of an entity that guarantees that relevant contractual payments will be made to a nominated third party (a form of promissory note). In the event that the underlying customer is unable to meet its obligations, the relevant third party can present the Letter (providing it is within its validity period) to the bank to receive payment. The bank will then have recourse to the underlying customer for recovery of the amount paid.

77 This type of instrument is used in the power generation sector to guarantee obligations under connection agreements, to underpin credit support needs for energy trading exposures, or for fuel supply agreements.

78 Generally such Letters are used where there is judged to be a low probability of them being required, and consequently they can offer recourse to significant cash resources, but at typically lower costs than would be applied to other types of debt where cash has already transferred.

79 On the assumption that banks will be interested in providing this type of facility, they would charge a fee for the provision of such Letters on the basis of:

- their judgement of the risk that an underlying event that may cause the Letter to be called upon will occur;
- the quantum of the exposure (this will be a fixed amount – such Letters are not open ended)
- the credit worthiness and cash resources of the underlying customer (the project) – essentially the banks judgement of whether their customer could meet their obligations from their own resources.

Insurance

80 The UK and Global insurance markets have substantial experience of assuming large scale environmental and catastrophic risks, and have proven themselves to have the capacity to accommodate major claims, although their ability to do so is based on extensive actuarial data, and clear views of the risks assumed and probabilities.

81 Whilst it is possible that the market may judge the total risk to be uninsurable, if the quantum of the exposure can be capped, and is known to decline as funding builds up, the market may be able to structure a product that offers adequate coverage.

82 This type of insurance will be bespoke, and will require substantial development by any interested insurers. Issues to be addressed will include:

- what circumstances will constitute a valid claim (what scope will there be for the insurer to escape liability);
- what conditions will be imposed that may, if breached, invalidate the insurance (reasonable and prudent operator standards as an example)
- what excess will apply, and should this be separately funded at project commissioning?
- premiums will vary over time, and may rise substantially as view of risk develops
- insurance is generally only available in yearly contracts, and there is no guarantee that economic insurance could be bought throughout the operational life of the project.

Parent Company Guarantees

83 Parent company guarantees may offer the cheapest form of indemnity, particularly if the credit rating and capacity of the companies concerned is high. However, the value of such a guarantee may decline over time in proportion to the parents' relative rating. Further, such guarantees or support undertakings may be withdrawn (TXU example), and can not be assumed to be enduring.

Apportioning regulatory risk

84 As noted in paragraphs 32 - 35, the estimated costs of decommissioning may increase throughout the operational life of a station as a result of several factors. A significant factor in evaluating a potential NNB project (as it is mostly outside the control of the operator) is the likelihood of the regulatory or statutory framework changing, after committing to the project, with the consequent effect of changing the scope of, approach to, or timing of the required decommissioning activities.

85 As the probability of such changes occurring increases as the operational life of the station elapses, their impact on the then NPV of the future costs, and consequent increases in the remaining funding obligation to be paid, will become progressively greater, with less time to fund them, and fewer years discounting or fund growth to mitigate their impact.

86 A developer will have very limited (if any) experience on which to base any prospective or probabilistic assessment of what such changes might be, and hence their financial impact. Consequently this risk will weigh heavily, as it is neither readily quantifiable, nor limited.

87 A possible approach to the mitigation of this issue is to develop some form of Regulatory Risk Insurance scheme. Such insurance is unlikely to be provided by the insurance industry, as the underlying risk is wholly related to actions by Government or its agents, and hence such a mechanism may require Government support.

88 Alternatively, it may be possible to apportion the risks such that the owner/operator bears the risk of cost increases arising from its operation of the station, whilst Government bears the risk of basis change. This approach may give rise to difficulties in definition, and potentially therefore, dispute over responsibility.

89 Alternatively, and operationally more simply, it may be possible to apportion the risk between owner and Government arising from regulatory change on a capped basis. The owner may be required to bear the first specified increment of cost increases caused by regulatory change (this may be more susceptible to external insurance, as the liability is capped), with any excess borne by Government.

Treatment of British Energy plc's decommissioning liabilities

90 Upon its privatisation in 1996, a number of measures were put in place to seek to provide assurance as to the funding of BE's reactor decommissioning liabilities. However, these were subject to substantial change upon the restructuring of BE in 2004. The positions prior to, and after, restructuring are summarised below.

Prior to restructuring

91 BE retained all liability for decommissioning, and was expected to be responsible for the total costs of its execution. Decommissioning itself was broken down into 3 Stages, which were to be funded in two different ways:

92 Stage 1

- the preparatory work in the three years prior to cessation of generation that was required to gain approval to, and facilitate the proposed decommissioning strategy;
- de-fuelling of the reactor itself, expected to take some two years post cessation of generation;
- engineering preparatory work making safe redundant systems and plant, and general facilitation works in anticipation of more substantive decommissioning or safestore; and
- dealing with potentially mobile operational wastes.

93 This stage of work was to be funded out of BE's operational cashflows, and was not subject to any specific requirement for the segregation of funds.

94 Stage 2

- development of the safestore structures for the reactor and radioactive waste buildings (in the case of Sizewell B being assumed to be approximately 10 years after end of generation);
- Site care and maintenance and security; and
- Decommissioning of other plant and facilities not subject to safestore.

95 Stage 3

- retrieval and management of stored active wastes on the reactor site; and
- Physical dismantling of safestore, reactor and waste structures, and site clearance to return to alternative use, including de-licensing.

96 In the case of both Stage 2 and 3 costs, these were subject to a requirement for BE to provide cash funds into a segregated fund, the Nuclear Decommissioning Fund (NDF) held off BE's balance sheet.

97 The NDF was formed at BE's privatisation, and was owned by The Nuclear Trust, an irrevocable Scottish Trust established by deed on 27 March 1996 between BE, the Secretary of State for Trade & Industry, and five Trustees (3 appointed by the Secretary of State, 2 by BE). The five Trustees were also the directors of the Fund.

98 The key characteristics of the Fund were:

- Established with a £228m initial endowment, followed by quarterly payments of £4.5m (indexed)
- Invested principally in equities and property (some 85% equity, 15% property at restructuring), but assumed on basis of actuarial advice to deliver a real rate of return of 3.5%
- That contributions would be re-assessed at 5-yearly intervals, based on actuarial and technical input (the 2001 review concluded that there was a need to increase the funding to increase prudence regarding waste)
- The actuarially assessed value of the fund was targeted to be 110% of the discounted value of the liabilities.

99 It should be noted that the Fund lost some 20% of its market value between 2001 and 2003 primarily as a result of the decline in the equity markets, and BE would have been required to substantially increase its contributions to the Fund (had it not commenced its restructuring) to make up the deficit, as well as increasing its contributions to reflect the assessed under-provision noted above.

After restructuring

100 A new Fund was established, the Nuclear Liabilities fund (NLF), with a comparable structure to that of the NDF (being a fund owned by an independent Scottish Trust, with the 5 Trustees also being directors of the Fund, and with equivalent appointment rights as for the NDF).

101 The NLF assumes responsibility for all decommissioning costs from the point of cessation of generation (i.e. vast majority of Stage 1 costs previously not captured by the NDF), but also takes responsibility for other fuel and waste costs (known as the Uncontracted Liabilities).

102 The NLF is funded as follows:

- Transfer of NDF at its market value
- Receipt of £275m of New BE Bonds;
- Annual funding obligation of £20m, indexed;
- £150,000 per tonne of fuel loaded into Sizewell B, indexed; plus
- a cash sweep of 65% of available free cash.

103 Further, in the case of the NLF, Government acts as funder of last resort, as BE has no further obligation beyond the specific charges noted above, irrespective of the actual costs, or changing estimate of the costs, of the future decommissioning liability. As a quid pro quo, excess amounts in the NLF can be distributed to Government, under certain conditions.

104 Because of the assumption of open-ended liability by Government, a number of provisions have been applied to seek to incentivise BE to minimise likely costs, whereby the NLF will not be responsible for incremental liabilities arising from BE's failure to meet a Reasonable and Prudent Operator test, or in the event of its breach of NIA 1965 licence obligations.

Emerging conclusions

105 Achieving a balance between minimising risk to Government, whilst also increasing certainty, and reducing open-ended liability to the project developer is the key issue in most aspects of the consideration of decommissioning liabilities.

106 Government may have to assume certain risks, in defined circumstances, in return for placing a greater obligation on projects, such as a segregated decommissioning funding obligation.

107 An obligation to specifically and irrevocably segregate or transfer cash from operations is considered to be an appropriate mechanism to mitigate risk, and enhance confidence that sufficient cash funds are being set aside for decommissioning – however, there are a significant number of detailed issues that must be addressed to achieve its implementation.

108 In the context of possible NNB, a number of aspects of the scope, boundary and responsibility with regard to decommissioning require clarification (refer to Appendix B), not least because all precedent in the UK relates to publicly owned decommissioning assets

APPENDIX A

Decommissioning Cost Estimates for New Nuclear Build

Background

1 It is considered likely that any new nuclear reactors constructed in the UK will be of a Light Water design, most likely a Pressurised Water Reactor ("PWR"), but with a Boiling Water Design ("BWR") also being conceivable. The two leading designs of PWR are Areva's 1,590MW EPR, and Westinghouse's 1,100MW AP1000.

2 Both designs are developments of predecessor reactors. Whilst the EPR is under construction by TVO in Finland, and has now been selected for the recently sanctioned EdF project at Flammanville in France, neither has yet reached an operational stage, nor have many of their predecessors yet reached an advanced stage of decommissioning.

3 Consequently, information with respect to the potential costs of decommissioning these new reactor variants has to be drawn or interpolated from proxy data. The main sources of such information are:

a. Reactor vendor own estimates and assertions
b. Actual data from decommissioning reactors (of earlier generations);
c. Third party academic or research studies

4 It must also be noted that the final actual costs of decommissioning will vary significantly from country to country and plant to plant due to differences in public policy and plant design. There is a lack of specificity or disclosure of many of the key assumptions that underpin estimates, and hence it is considered critical to treat with caution single value estimates stated by a number of the sources.

Vendor Estimates

5 Both Areva and Westinghouse have given public presentations which have included statements regarding the anticipated costs of decommissioning their new reactor designs, and Areva's submission to the Energy Review (page 17) also refers.

6 Based upon these public statements, supplemented by private meetings with both vendors, the following summarises their respective positions:

Areva

7 Areva's stated position is that costs will be £191m/GW (2004 mv), being 15% of assumed construction cost.

8 This figure has apparently been determined on the following basis:

a. Based on an EdF study in the mid 1990s of prospective costs of decommissioning the four 900MW Dampierre PWR reactors;
b. Based on the assumptions made by EdF as to the approach to the decommissioning of that reactor type, being work that will not be undertaken for a further 15 – 20 years;
c. Based on a room-by-room engineering study;
d. Assumes "Greenfield" end state, but in France this is for industrial use, hence could not build a school, or make available for completely unrestricted access;
e. Costs are those from the end of the de-fuelling period, and reflect an expected period of some 15 – 20 years to complete the decommissioning;
f. Study assessed costs as likely to be between 15% and 20% of total construction cost (but could be outside this range), but that applying 15% was a "sustainable" assumption.

9 Areva note that they themselves have not performed any detailed engineering studies of the possible costs, nor have they sought to validate or update the EdF figures, although their own experience of decommissioning facilities at Cap de la Hague gives them comfort on the achievability of decommissioning.

10 In assessing the Areva estimate, it is therefore considered prudent to make the following adjustments:

	£m/GW
Areva stated figure (2004 mv)	191
To reflect 15% - 20% range	191 - 255
To reflect construction costs 15% higher	220 - 295
To reflect true Greenfield end state	240 - 325
To update to 2006 mv	255 - 345

Westinghouse

11 Westinghouse's stated position is that costs will be £327m for a single AP1000 unit in 2002 money values, based on BNFL presentational material delivered on 13th May 2004.

12 This figure is determined on the following basis:

a. Based on a BE study in 1991 of the prospective costs of decommissioning the Sizewell B PWR, then in construction;
b. Based on the assumptions made by BE at that time, but BNFL then applied judgement to interpolate to potential costs for an AP1000;
c. Assumes an end state in which the site is "ready to be de-licensed, but still has packaged waste on site";
d. Costs are those from the end of the operational life, and hence include de-fuelling, and reflect an expected period of some 15 – 18 years to complete the decommissioning;
e. Includes the decommissioning of Spent Fuel stores, but only for stores capable of holding 10 years arisings;
f. Other end-of-life costs, such as redundancy etc are excluded, and considered to be operational costs.

13 Again, Westinghouse has not undertaken a detailed assessment of the costs related to their own design.

14 In assessing the Westinghouse estimate, it is therefore considered prudent to make the following adjustments:

	£m/GW
Westinghouse stated figure (2002 mv)	300
To reflect true Greenfield end state	310 - 325
To update to 2006 mv	340 - 360

Decommissioning Experience

15 Few large scale commercial PWR reactors have reached advanced stages of decommissioning, however there are examples in the US where work is substantially complete, and the radiological decommissioning has been completed to NRC satisfaction. Two key examples are Maine Yankee (a 900MW PWR) and Trojan (a 1,155MW PWR).

16 In both cases the nuclear facilities have been dismantled, but other structures remain, and in the case of Maine Yankee, certain wastes remain on site in a packaged form in newly engineered facilities as a consequence of the unavailability of Yucca Mountain. (Hence the stated costs cannot be treated as being for a complete greenfield decommissioning.)

17 In both cases, the stated costs are those incurred to-date, plus those yet to be incurred on completion of physical dismantling, but exclude all those costs associated with Spent Fuel storage on site.

18 Costs disclosed are as follows:

Site	Disclosed costs	Estimated (2006 mv)	Links
Maine Yankee	US$440m (2001 mv)	£360m per GW	www.maineyankee.com
Trojan	US$300m (1997 mv)	£220m per GW	http://egov.oregon.gov/PUC/meetings/pmemos/2005/030805/reg4.pdf

Third Party Studies

19 A number of studies have been performed, including academic and industry body work, as well as analysis being performed by brokers such as Morgan Stanley to assess the level of provisioning being made by European utilities operating PWRs.

20 The more recent or more comprehensive of these studies are summarised in Appendix A.

21 As referred to earlier, there are a range of assumptions and approaches that may underpin the data in these studies, and many of these will not be explicit or visible. Further, much of the data represents expected costs of decommissioning activities that will be performed in the future, and hence can not be treated as empirical historical data.

Conclusions

22 In summary, the differing sources of data can be summarised as follows:

Source	Indicated cost £m/GW(2006mv)	Adjusted estimated cost £m/GW(2006mv)	Comments
VENDORS			
Areva	202	255 - 345	Excludes de-fuelling, hence figure would need to be higher if to compare with AP1000
Westinghouse	325	340 - 360	Includes de-fuel phase
PRECEDENT			
Maine Yankee	360	360	Spent Fuel still on site in new facilities
Trojan	220	220	Spent Fuel still on site in new facilities

THIRD-PARTY STUDIES			
Morgan Stanley	311		Average of a wide range
OECD	220+	135 - 270	
US DoE	250+	250 - 300	

23 These figures have not been increased to reflect any additional contingency or risk margin, but the source figures may include some such provision.

24 On this basis, it is considered reasonable to conclude that the available data sources point to a central estimate for the decommissioning of a PWR in the range of £250m - £350m per GW (in 2006 money values). However, these estimates are unlikely to include much provision for estimating and other contingency, and consequently a prudent assumption would be to increase the range by a factor of 1.2 to reflect that contingency, and to accommodate some of the potential differences in precise interpretation and assumption base. This would give rise to a range of between £300m and £420m per GW.

25 On the assumption that each new reactor operates for either 40 or 60 years, at an average load factor over life of 85%, and with the undiscounted cost spread across actual generation hours, the effective cost per MWh of generation, determined by the DTI model, would be:

Assumed cost/GW	**£/MWh – 40 year life**	**£/MWh – 60 year life**
250	0.84	0.56
300	1.00	0.67
350	1.17	0.78
420	1.41	0.94

26 Applying a 2.5% discount rate to the total decommissioning costs over the 40 or 60 year lives reduces the £/MWh cost to a prospective:

Assumed cost/GW	**£/MWh – 40 year life**	**£/MWh – 60 year life**
250	0.31	0.13
300	0.38	0.15
350	0.44	0.18
420	0.53	0.21

APPENDIX A

Estimated Reactor Decommissioning Costs

Source	Reactor type	Cost estimate	Comment	2006 mv cost estimate
"Decommissioning Nuclear Power Plants: Policies, Strategies and Costs" – OECD/NEA 2003	PWRs – range of countries	Average U$320/GW, with range of U$200m – U$400m for larger reactors	Expressed in July 2001 money values, reflecting 19 reference PWR reactors	£220/GW average, with range of £135m - £270m
Dominion Energy for US DoE, 2004	4 designs, including AP1000	U$416m for 1,150MW unit	Quoted as 2003 money values, does not include full demolition, but achieves de-licensing in US	£250m/GW (though likely to be higher for total demolition)
Bayliss and Langley	Average PWR - USA	U$368m	1998 money values to licence termination NEI study of 60 PWRs from 500MW to 1,095MW, with and without full disposal and site remediation	£265m (assuming average size of 750MW)
	Average BWR - USA	U$420m	1998 money values to licence termination NEI study of 30 BWRs from 540MW to 1,140MW, with and without full disposal and site remediation	£300m (assuming average size of 800MW)
	Various reactors	Eur275M – Eur600	1997 – 2000 UNIPEDE study, covering 12 countries (10 in Europe), assumed 1998 money values	£230m - £500m (no reference MW)
US Uranium Info Centre	Average reactor	U$325m	1998 money values, range between U$280m and U$612m (described as being reduced estimates based on experience)	£235m (range of £200m - £440m, with no reference size)
Morgan Stanley research	European fleet	Eur260m – Eur800m per GW installed	Based on disclosed provisions of E.On, RWE, Electrabel, Fortum and CEZ, generally 2004 money values.	£190m - £590m per GW

	PWR	Eur110m – Eur1.1bn per GW installed	Based on data from 21 sites. Average of Eur396m, in 2001 money values	£311m per GW (average)

Notes on APPENDIX A

1. Bayliss and Langley data from "Nuclear Decommissioning, Waste Management and Environmental Site Remediation". Oxford: Elsevier, 2003
2. Cumulative inflation factor for USA between 1998 and 2006 is 1.22, and between 2000 and 2006 is 1.15 (US Department of Labor statistics, http://data.bls.gov/cgi-bin/cpicalc.pl)
3. Cumulative inflation factor for Europe between 1998 and 2006 is 1.16, between 2001 and 2006 is 1.10,and between 2004 and 2006 is 1.03 (ECB European inflation data)
4. US$ translated at 1.7, Eur€ translated at 1.4.
5. Morgan Stanley *Nuclear Prospects*, Sept. 2005:

Exhibit 39

NEA Decommissioning Costs * (€/kW Installed Capacity)

Reactor Type	Number	Low	** High	Median	Mean
Pressurised Water Reactor	21	110	1,076	396	396
Boiling Water Reactor	11	90	2,723	536	758
PWR of Soviet Design	8	192	599	376	388
Press. Heavy Water Reactor	7	318	513	453	429
Gas Cooled Reactor	6	320	5,292	2,000	2,378
Total	**53**	**90**	**5,292**	**408**	**698**

** Figures are translated from 2001 US$ to €.*
*** High estimates are distorted by small reactors with relatively high decommissioning costs, which leads to high specific costs*
Source: NEA, Morgan Stanley Research

Exhibit 48

Estimated Implied Decommissioning Costs

	E.ON	RWE	Electrabel	CEZ	British Energy	Fortum
Reported Decommissioning Provisions (€mn)	8,204	4,131	1,490	303	1,512	252
Weighted Average Year of Decommissioning Cash Flows [1]	2,037	2,024	2,026	[2] 2,055	[2] 2,060	2,026
Company Nominal Discount Rate (%)	5.6	5.5	5.0	7.0	[3] 5.5	5.5
Implied Future Decommissioning Costs (€mn)	46,911	11,425	4,150	8,634	29,020	776
Company Inflation Rate (%)	5.6	4.8	2.0	4.5	2.4	3.0
Implied Decommissioning Costs At Current Prices (€mn)	8,204	4,688	2,738	[2] 977	[2] 7,840	417
Installed Capacity (MW)	10,181	6,884	5,802	3,760	9,568	1,420
Implied Decommissioning Costs Per kW Installed Capacity (€)	806	681	472	260	819	294

1. *Estimates are based on weighted average plant closure years plus company information about cooling down periods and decommissioning cash flow profiles.*
2. *CEZ and British Energy disclose decommissioning costs at current prices. The weighted average year of decommissioning cash flows have therefore been inferred.*
3. *British Energy only reports its real discount rate, we estimate the nominal discount rate.*

Source: Company data, Morgan Stanley Research estimates

APPENDIX B

Decommissioning - issues of principle to be clarified or addressed

Whilst the ultimate objective of the decommissioning activity is clear – returning the site to an agreed status, potentially for alternative use, at the cost of the owner/operator, there are currently a number of aspects where there is a lack of clarity from both Government and a developer's perspective.

Scope and definitions:

- Clarity as to the definition of the boundary between "waste" and "decommissioning" costs in order to avoid dispute regarding the responsibility for the costs of, for example, wastes arising from decommissioning activities;
- Will the NDA, or an equivalent, take responsibility for the decommissioning activity in all cases, or will the responsibility, as well as the liability, lie with the owner/operator? At what point will transfer of responsibility to the NDA take place, and how will this process be governed?
- What is the base-case standard required for decommissioning (green-field; within defined timescale; with lifetime operational conditions on strategy and impact?). At what point in the project evaluation process is this agreed, and how is the estimate of costs and contingencies derived and settled between owner and regulator?

Regulatory risks:

- Regulatory risk that the NII, HSE or their future equivalents, or primary legislation itself, will alter the base-case requirement, and consequently increase the costs, or bring forward the timing of the decommissioning activity;
- Changes imposed on the operational regime (fuel-route, storage requirements etc) may add to the extent of facilities to be decommissioned;
- Failure of Government to deliver a waste repository may increase the capex, operational and decommissioning costs of plant as additional on-site storage is required (as in US), and may prevent the execution of the intended strategy;
- Decisions made elsewhere on long-term storage solutions (such as on-site shallow burial of wastes) may prevent de-licensing of a site, or its return to alternative use.