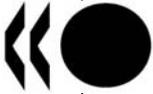


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RADIOACTIVE WASTE MANAGEMENT COMMITTEE**

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Working Party on Decommissioning and Dismantling (WPDD)

Topical Session on Funding Issues in Connection with Decommissioning of Nuclear Power Plants

9 November 2004

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English - Or. English

Working Party on Decommissioning and Dismantling (WPDD)

**Topical Session on Funding Issues in Connection With
Decommissioning of Nuclear Power Plants**

Held in Paris on November 9, 2004

Paris January 21, 2005

FOREWORD

Set up by the Radioactive Waste Management Committee (RWMC), the WPDD brings together senior representatives of national organisations who have a broad overview of Decommissioning and Dismantling (D&D) issues through their work as regulators, implementers, R&D experts or policy makers. These include representatives from regulatory authorities, industrial decommissioners from the NEA Co-operative Programme on Exchange of Scientific and Technical Information on Nuclear Installation Decommissioning Projects (CPD), and cross-representation from the other NEA Committees. The EC is a member of the WPDD and the IAEA is participating as an observer. This broad participation provides good possibilities for the co-ordination efforts amongst activities in the international programmes.

At its fifth meeting, in Paris, 8-10 November 2004, the WPDD held a topical session on the “Funding Issues in Connection with Decommissioning of Nuclear Power Plants. This report documents the topical session on Funding. An agenda of the Topical session can be found in Appendix 1.

The topical session was meant to provide an exchange of information and experience on the following issues:

- Ethical Values
- Actual Experiences of Fund Setting and Management
- Uncertainties in Funding

Mr Olof Söderberg, Member of the Board of the Swedish Nuclear Waste Fund and Expert at the Swedish National Council for Nuclear Waste (KASAM), served as Session Chair. Mr. Vincent Massaut, Head of the Waste & Clean Up Division of SCK•CEN served as the rapporteur for the Topical Session and has provided the main text for the summary part of this report.

At the end of each session time was allotted for a plenary discussion. The rapporteur reviewed the main points and the lessons learnt at the end of the whole Topical Session.

The Topical Session is documented as follows. A summary of the presentations, the country reports, the discussions and the key issues and lessons learnt is given in the main part of this report. The agenda of the Topical session can be found in Appendix 1 and the full papers supporting each presentation are given in Appendix 2. The national presentations on “Actual experiences of Fund Setting and Management” in session 2 can be found in Appendix 3 and the national presentations on “Uncertainties in Funding” in session 3 can be found in Appendix 4.

As a follow-on to the Topical Session a Task Group has been constituted in order to write an executive summary for these proceedings possibly followed by a separate Status report on the Funding issues. The participants of this Task Group are:

Mr. Olof Söderberg	(Chairman)
Mr. Harald Maxeiner	
Mrs Ivana Davidova	
Mrs Gerda Bal	(replacing Mr. Marnix Braeckveld)
Mr. Jean-Guy Nokhamzon	

Acknowledgement

The RWMC wishes to express its gratitude to Mr. Olof Söderberg for chairing the topical session, and to Mr. Vincent Massaut, for acting as rapporteur.

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SUMMARY OF THE PRESENTATIONS AND DISCUSSIONS

Session 1: Ethical values

The first two presentations were given by specialists in human science, and focused more on the ethical aspects of the funding for decommissioning.

Some new aspects or approaches were presented, which allowed to highlight the egalitarian and utilitarian approaches of intergenerational equity.

The different ethical principles led to conclude on the need of a democratic debate on the subject, and the need of ethical guidance at international level. Some other key points, like the preservation of competences, funding and resources, were also considered in the light of the intergenerational community (3rd principle of justice).

The session was concluded by a presentation on the application of the ethical principles for the funding (in fact, this application was mainly oriented towards the selection of solutions or options for the radioactive waste disposal).

The results of this Swiss expert group study led to the following conclusions:

- Democratic debate is needed for all boundary conditions.
- Same rights must be guaranteed for all generations.

This led to some technical decisions (e.g. retrievability) mainly for waste management and disposal.

The general discussion that followed led to the following conclusions:

- International guidance is needed on ethical values.
- Intergenerational solidarity must be guaranteed.
- Freedom of choice of future generation must be respected.
- Funding is probably not the primary ethical problem but well the guarantee of safety of present and future generation.

Session 2: Actual experience in funding

The various mechanisms for funding have been analysed on their principle, current practice and merits.

Three main aspects were analysed:

- How funds are raised?
 - ↗ discounted or not
 - schedule
 - ↘ collection system
- How are the funds managed?
- How to disburse when needed?

The actual experience in different countries showed different mechanisms and return of experience:

- In Germany, the funds are set aside internally. The system functions very well and Germany does not see any reason to change it.
- In Spain, Enresa is responsible for managing and disbursing the funds. The estimates are based on discounted costs, with an average discount rate of ~2.5%. The fund is raised by a levy on electricity production.
- In Switzerland, the decommissioning fund was established in 1984. It is based on 40 year operational lifetime. The net interest rate was estimated to be 2% (~4% actual average). In case of problems (bankruptcy), there is a 2 step system that will be put in place: first step solidarity between producers; if this fails the State is the final guarantee (second step).
- For the US, the system is also put in place with rather defined rules, but the change in the electricity market caused some difficulties, with the presence of Energy merchants independent of the producer.
 - The US have also experience of large NPP decommissioning, with fixed cost contracts, where both estimates were much too low; therefore the licensee had to take over the job.
 - Also the problem of early or premature shut down has been raised, mainly with new energy merchant companies.

The general discussion that followed led to the main conclusions as follows:

- Mostly the funds management control is important, not the type of management (segregated, external or not).
- The visibility & transparency of the funding were also recognized as important aspects of the funding management.
- A question was also raised (by IAEA) concerning the funding for facilities other than NPP. Are there specific aspects which should be taken into account?

Session 3: Uncertainties

In most large industrial projects (construction, civil works, aerospace...), the return of experience shows that overrun (in time and cost) is a rather general tendency. But it depends on the type of project, on the degree of innovation, etc. Some means to avoid these overrun were presented.

In the case of D&D, the main uncertainties affecting funding can be found in:

- cost estimate
- inflow of resources
- management of resources
- time factor: when will the costs occur?

Moreover, these uncertainties sources can also be interlinked. One of the conclusions from this analysis is that the existing uncertainties in funding are good reasons not to postpone decommissioning operations to a too distant future.

National presentations on return of experience can be summarized as follows:

- In **Finland**, a system is in place.
 - The system covers future cost of existing waste, but no discounting is allowed.
 - Fund is put in segregated fund; the waste producer has the right to borrow up to 75% of funds; the State can borrow 25%.
 - The system is well defined, and proved to work quite well, at least for waste management facilities.
- In **France** there are important changes upcoming.
 - The evolution of the EDF statute (towards more private system).
 - Areva could go privatized (i.e. shares would be on the stock market).
 - Open competition of electricity in the European market.
 - France intends to modify its funding system in accordance with EU regulations or proposals, paying attention to the market opening. Therefore, France was much in favour of the “nuclear package” proposed by Commissioner Loyola de Palacio, and favoured the inclusion of D&D in the package. Currently, the system is back to the EU institutions and the Council would decide on a legal system in 2007.
- In **Germany** there is no site/facility specific legislation or regulation.
 - The financing of D&D follows the principle of “polluter pays”.
 - The method of funding is different for public and private facilities:
 - for public facilities: by annual payment (budget)
 - for private facilities: collection of reserve during operation (linear accumulation over 25 years). The total national reserve today amounts to ~30-35 B€ including waste disposal.

- The cost estimates are made by the operators, they are based on detailed planning and a large practical experience. They need to be assessed conservatively. The review of funding level is made by the tax authority.
- The experience till now is good and the funds were available when needed.
- It is intended to review the funding system and find out whether it is still adequate or whether it needs modifications because of changes in the nuclear scene, e.g. the nuclear phase out (as decided by Parliament), the new approach to waste disposal and the electricity market deregulation. Discussions are thus ongoing but decisions have not yet been made.
- In **Italy** the plants were prematurely shut down, and not enough money was set aside during the plants lifetime.
 - A few years ago, there was a new input from the Government: “to finish the D&D of all installations by 2020”.
 - ENEL (former nuclear facilities) had provisions (from operation) and credit from the State. This funding was considered enough for D&D following the safestore strategy (taking the discounted cost into account).
 - These funds (~800 M€) were assigned to SOGIN, when created. It was not then considered as sufficient for the 4 NPPs.
 - Today estimates are approximately 2600 M€ for the NPP's and 630 M€ for the research plants (in constant money 2002).
 - The Government then decided to set up a levy on electricity production (about 0.0006 €/kWh).
 - Every year, SOGIN has to present the schedule and cost of D&D to the Government.
- In the **UK**, the complex situation was first presented historically.
 - In 1976, an internal unsegregated fund was set up.
 - In 1990, the electricity sector was privatized, the funding disappeared.
 - Afterwards, there was the creation of Nuclear Electric (public company).
 - In 1996, privatization of the AGRs and PWR. Set up of an external segregated fund.
 - In 1997, the old Magnox stations were transferred to BNFL.
 - The Nuclear Decommissioning Authority (NDA) was founded in the UK. It will be operational by 1 April 2005. This is the fifth reorganization affecting the nuclear decommissioning scene. In all the reorganizations funds were lost for the envisaged purpose. In this case the BNFL segregated internal funds, for example, were transferred into the treasury. Only in the case of British Energy (BE) the segregated funds remained with the company.
- For the **US**:
 - Currently, there are about 20 NPPs in decommissioning (about 50% with the immediate strategy).
 - The licensee is responsible for funding and carrying out the clean up.

- 5 approved funding systems are existing, including the pre-payment and the insurance; the most popular being the system with external account.
- The cost estimates are reviewed in depth on 3 occasions:
 - Preliminary: 5 years before shutdown
 - Post shutdown: 2 years after shutdown (how to cover the D&D costs)
 - Final: 2 years after license termination (how to remediate the site). (The question of whether this is enough was raised).
- Some positive and negative experience:
 - Positive: up to now the system showed to be adequate in obtaining and managing the money
 - Negative: mainly in non nuclear utility sector.

Plenary discussions

Summary

The plenary discussions allowed to tackle the different aspects presented during the day. Some key points can be highlighted:

- The main question seems to be: “What are the elements making the funding system safer?” This can be looked at through different aspects:
 - cost estimate;
 - control of the funding and money collection;
 - control of investment of the money;
 - how to cope with uncertainties (including early shutdown and bankruptcy).
- The stability of the funding system over the time is a key factor for securing the funding (a good counter-example is the UK story).
- The decommissioning exercise should start before the plant is in operation; i.e. when a plant is constructed!
- An important aspect is also the information exchange with people having participated to actual D&D projects.

Discussions by session

At the plenary discussions the following items were also recorded:

Session 1 – Ethical values

A discussion was held on the possibility of having an international body managing decommissioning funds. It was argued that the risk for misuse of the funds might be less with such international management. However, responsibility questions and the availability of the funds at the right time might be difficult to handle if managed by an international body. National management bodies were mostly favoured and it was stressed that it is important that managing and controlling of the funds are done by different and independent national bodies.

The autonomy and freedom of each national fund management organisation to make its own decisions, including mistakes, was emphasized. The willingness to learn from others is sometimes limited. There must be respect for the freedom of choice both between the various funding options. Different generations may also decide differently. Knowledge management and ways to transfer information between generations will be important from an ethical point of view.

Other questions touched upon were how far the present generation would need to go today to protect future generations from a virtual risk and how far do these ethical considerations need to be covered by the funds? No clear answers can be given because of the speculative nature of such questions. Uncertainty (in cost calculation, the success of an investment etc.) should be considered when raising the funds.

The importance of having funds available at the right moment was stressed.

The use of ethical values in the discussion with the public and the stakeholders was discussed. When using positive expressions like “Common good”, “equity”, “fairness” etc. it must be perfectly clear of what is meant and it is necessary to explain the terms in a simple and transparent way. Some of the wording is very theoretical, but if used in a reasonable way it can be very useful in the discussions.

Session 2 - Actual Experiences of Fund Setting and Management

A discussion was held on the pros and cons of segregated funds. Many arguments were raised in favour of segregated funds but it became also very clear that considerable risks are involved in segregated funds.

It was concluded that a proper management of funds is very important. Examples of financial losses in funds were given by Switzerland (losses in some years) and the UK (loss of funds for the purpose due to reorganisation, privatisation etc.). It was stressed that the funds, and how they are managed, should always be visible and transparent.

It was clear that there are different possibilities for raising funds. Once a system is put in place it is hard to change it. There are no such things as good or bad funding systems. Every system has advantages and disadvantages. It is important to analyse the various funding system to identify weak points and provide solutions how to minimise risks associated with such weaknesses instead of continuing with the theoretical discussion on “the best” system. WPDD may take a lead in the respective analyses.

Session 3 – Uncertainties in funding

It is important to identify the features that make the funding systems safe. Key issues are the management and control of funds. The stability of the funding systems is essential and the way how to cope with uncertainties.

Decommissioning should be taken into account already in the design phase of a facility to minimise the uncertainties. The planning of the decommissioning of a specific facility can be allowed to take a lot of time and thereby you can have the best technical solutions available.

Although decommissioning is a mature industry a lot of site specific surprises may occur which make cost estimates difficult. A discussion on how to avoid cost overruns is probably an area where more work could be done.

Information exchange between decommissioning projects is very valuable and there is a lot of information that can be used in planning of future decommissioning projects. International co-operation on these issues is encouraged.

Creating of a Task Group on Funding

Regarding the importance of the topic and the interest shown to get further analysis on the subject, it was decided to set up a Task Group on the subject with the following members (provisory list):

O. Södeberg (Chairman)
H. Maxeiner
I. Davidova
M. Braeckeveld
J.G. Nokhamzon

The outcome of the Task Group will then be presented to the WPDD in a future meeting.

Appendix 1

**AGENDA FOR THE TOPICAL SESSION ON FUNDING ISSUES IN CONNECTION WITH
DECOMMISSIONING OF NUCLEAR POWER PLANTS**

NOVEMBER 9, 2004

**TOPICAL SESSION ON FUNDING ISSUES IN CONNECTION WITH
DECOMMISSIONING OF NUCLEAR POWER PLANTS**

**Held during the 5th meeting of the RWMC Working Party on
Decommissioning and Dismantling (WPDD)**

(Item numbers according to the WPDD Meeting in which the Topical Session was a part)

Chair: O. Söderberg

9TH NOVEMBER

- 10. TOPICAL SESSION ON FUNDING ISSUES IN CONNECTION WITH DECOMMISSIONING OF NUCLEAR POWER PLANTS**
Chair: O. Söderberg
- 9:00 **10.a Introduction, Aim and Scope of the Topical Session**
- 9:10 **SESSION 1 – ETHICAL VALUES**
Chair: O. Söderberg
- 9:10 **10.b Why an Open Common-knowledge Process about Decommissioning Funds? How Transparency Supports Democracy**
M. Bovy, SCK•CEN, (Belgium)
A presentation on inter-generational and intra-generational equity issues with bearing on decommissioning of NPPs.
- 9:30 **10.c Ethical Guidance**
C.R. Bråkenhielm, KASAM, (Sweden)
A presentation on general principles to be applied in funding long-term projects (such as decommissioning of NPPs) and the reasonable hierarchy between such principles.
- 9:50 **10.d Practical Implementation of Ethical Principles: the Swiss Example**
H. Maxeiner, (Switzerland)
A brief presentation of how ethical principles have influenced Swiss policy on waste disposal technology and managing of decommissioning funds.
- 10:10 **10.e Plenary Discussion**
- 10:30 **10.f Short Summary of Session 1 by the Chairman**
- 10:40 *Break*

- 16:00 **10.n** **What is Done to Ensure that Funds will be Available when Needed? Positive and Negative Experiences in Existing Systems**
Brief presentations (10 minutes) by national experts (operators or government representatives) from Finland (*Mr. J. Palmu*), France (*EDF representative*), Germany (*Mr. E. Warnecke*), Italy (*Mr. I. Tripputi*), UK (*Mr. G. McKerron*), USA (*by phone-Mr. T. Frederichs*).
- 17:00 **10.o** **Plenary Discussions**
- 17:25 **10.p** **Short Summary of Session 3 by the Chairman**
- 17:30 **SESSION 4 – SUMMARY AND CONCLUSIONS**
Chair: O. Söderberg
- 17:30 **10.q** **Summary of Key Findings during the Topical Session**
V. Massaut, (UK)
- 17:50 **10.r** **Closing Remarks**
O. Söderberg

Appendix 2

PAPERS

**TOPICAL SESSION ON FUNDING ISSUES WITH DECOMMISSIONING
OF NUCLEAR POWER PLANTS**

NOVEMBER 9, 2004

Session 1 – ETHICAL VALUES

WHY AN OPEN COMMON-KNOWLEDGE PROCESS ABOUT DECOMMISSIONING FUNDS? HOW TRANSPARENCY SUPPORTS DEMOCRACY

Michel BOVY
SCK•CEN, Belgium

ABSTRACT

Future generations will receive funds and have to manage the financial burdens linked to the technical heritage of the past nuclear activities. This shows the challenges of ethical requirements in this particular field, its cultural background as well as what it stands for. Another question is how the operators or the governmental bodies will interpret their decisions and justify these based on a hierarchy of principles where utilitarianism and egalitarianism have a central meaning. We aim at showing how a comparison of common criteria for decommissioning funds could help democracy and how a common knowledge could be developed by an open expertise process. The function of the control of the systems [1], that favours a democratic regulatory process in each country, calls for sufficient answers with regard to decommissioning funds, compared to other essential social needs. He has to adequately respond to the population with a higher degree of transparency in the priority of choices between different ways of using and controlling these funds. This asks for more social accountability and makes experts more responsible to Society for which they should work.

Keywords: Expertise, Decision-making Process, Nuclear Waste, Decommissioning, Funding, Ethics, Transparency.

1. INTRODUCTION

Ethics will never be excluded in making choices when one has to foresee sufficient provisions, or in giving authorisations and starting using these funds. The way to contribute to the funds and its origin or even the management rules of capital and interests have a direct impact on economic models that privilege certain ethical values. An ethical approach is incorporated in the balance between the short term and the long term, especially in investments protected by the State such as pensions or education needs in each country. Environment and human health thus gain a transversal dimension. Decommissioning operators and population need to start a debate when it comes to decide on an acceptable radioactivity level compared to the natural background. Ethics in decommissioning fund management finds direct answers, e. g. for giving trust to the operators or in the follow-up of irradiated materials when nuclear wastes are cleared and may circulate in the commercial waste stream of conventional industrial waste recyclers.

Through tradeoffs among several types of political priorities social values are expressed in a practical approach, but this is rarely considered *per se* as an autonomous social debate. We hold that ethics in social debates rarely is expressed prior to usual application. The ethical questioning is often used as a corollary of policy established by a network of tangled relationships between political

decision makers, experts and financiers. But it might also become a common framework of comprehension between several countries in order to promote a shared rationality. Numerous areas of applied ethics appeal for clear answers: the importance of an international manager, the writing of common rules for decommissioning cost assessments or even more, the independence of the fund manager protecting most of the public funds.

Long term governance can no longer sustain in situations when financial stakes enter into competition with market rules for operators and private investors. The management of decommissioning funds need guidelines that might be approved by all stakeholders and – why not – discussed openly in order to share a common approach that will undoubtedly make different opinions more acceptable. It is needed to allow a large scope for an ethical debate to know what is acceptable or not in a period of time that will largely outrun the energy production period. All advantages of courses cannot be situated only in the period of time of energy production. Advantages from the nuclear sites will stay later than the decommissioning period. The costs too.

This ethical reflection period can exceed the time for private institutions (even public ones) while they still have the capacity to meet financial needs which are indispensable for future generations. Ethical responsibility can be defined in terms of basic guidelines and coherent steps for provisioning and managing these funds. The present and past generations only take into account the future generations when they adopt the responsibility to write respective ethical guidelines.

Certain confusion may exist between the Western Philosophy of Equity and the economic market. The definition of equity in the market already asks for a particular philosophical approach. Equity refers to some concepts and models which are defined by finances and not by ethics. The utilisation of the concept of equity in the common good domain seems quite ambiguous without a preliminary explanation of the cultural context where it is defined. It needs a correct understanding of what we aim at defying when speaking about the equity concept in funding management. I appreciate the approach that defines the common good as something that deals with goods “outside the market” and at the same time tries to define the political good as an institution [2].

This shows the – explicit or rather implicit – normative background of the undertaking, coloured by the market and its concepts, especially as free-market economy wants to define what is right and fair by using the terminology of the “common good” (here shortly defined as a goal that any authority should tend to reach when working for the well-being and the welfare of the whole they represent and when dealing with goods whose accessibility and consumption are not entirely under market regulations). We see this, on the one hand, as a wrong shift between a relationship of supply and demand on the market and, on the other hand, a proposed philosophical approach analysing the differences between what is “good in common” (translation into the market approach: “acceptable”, “equity”) and what is “fair” (“right” in a European normative approach dealing with an ontological meaning of justice). Equity refers to stock exchange, to returns on investments and investment literature while equity in ethical terms deals with a sense of justice and fairness.

Below we clarify the differences between public interest and common good, avoiding the confusion between the legitimacy of the good from the market and the common good that must underlie guidelines for long-term governance. Financial transactions and equity, in this framework focused on immediate trade-off, create conditions in which people are easily forgotten and do not have a protected right for an access to the market because of their low incomes. In other words, the market often quoted as the barometer with its dominating rules of exchange, turns more and more to the one and decisive but overly implicit philosophical reference.

This is what also creates enormous confusion related to ethics when dealing with funding management. We thus wish to draw our reader's attention to the necessity of taking some precautions on the limits of a normative approach where the mathematical bearing only describes economic transactions without "social safeguards". Some arrangements in the management of specialised knowledge and capitalisation of funds in decommissioning project will help us to avoid believing in a false ideal about the well-grounded paradigm of these transactions with regard to distributive justice. Sometimes financial exchanges make implicit references that deal with social justice but not necessarily. Therefore we have to be cautious about the legitimacy of a framework of decommissioning funding and to make a clear distinction between the acceptance of the market and the fairness of the conditions underlying the market.

This immediately reveals, for the topic of the funding, the importance of having to know: what is an acceptable health level, acceptable environment quality and efforts for a country, even for a continent, to make provisions for future and present generations? How is the link built up with the capacity of each generation and country to contribute to the funding with its savings of today? Today we find, in politics and at global level, sharp protests against the model of the free market which does not sufficiently respect the population's needs. The growing gap between the common good defined by the market and the population's needs is a clear example of the loss of reflection on principles of justice. Where is the balanced answer given by any "welfare state" towards the variety of needed services that it has to offer to its population, facing the deficiencies of the free-market model?

The respect for individual rights and the capacity of any person to make his/her own choice regarding the definition of his/her own good must be the main base of any democratic system. It is hard to handle the common good for future generations [3] while the free market only "worries" about today's individual choices and is designed to aggregate maximizing their happiness. We should expect more of a decision-making process dealing with equity on the long term, making available for all the common good of future generations and properly balancing the sacrifices among them. This of course raises the question of having "fair" institutions to elect representatives for deciding what the common good is, expressed by the public, that deserves a financial answer from the community itself.

More representatives of the population's common good (elected people, media, NGO's...) [4] raise their voices reacting to the type of market where the economic meaning of the common good blends out the social inequalities to legitimate the forces involved in the market. Behind all this, one has to be preoccupied by elected leaders who have to make decisions in the short term [5] having an impact in the long term. The question is how to use funds balancing health, economic competition and technical specificities of nuclear waste for future generations. Respecting the population's needs requires the knowledge to put justice [6] and fairness into practice, but just up to where this respect ends and how it must be taken into consideration. This is particularly important for those to whom these financial expenses are being paid by the community.

An adequate decommissioning scenario (deadline, occupational safety) and proper financing are at the heart of this question. What is fair in view of the very open border between industrial production interests and social and public goods in the very long term? This leads us to examine the concepts of common good and public interest beyond the current economic transactions between operators. Especially those who carry out dismantling and the financial organisations charged to manage the funds.

2. A GLOBAL APPROACH

2.1 How Do Future Generations Care for the Long Term?

Some authors specialised in ethics on future generations have long underlined the importance of having a global approach for policies dealing with public interest, the environment and the control of public authorities. Among other principles B. Weiss [7] puts forward an ethical attitude that takes into account future generations in order to allow equal access to their own resources and make sure that these are available for next generations.

The balance between the burdens of the past and the present extends to requiring managers capable of enlarging the scope of the stakeholders who could have only seen their short-term interests defined by financial profits. Constituting these funds for decommissioning implies the ability of a political decider to shift from industrial interest to public interests [8].

The long-term guarantee of these funds encompasses the certainty to have institutions whose legitimacy is broader than those of the decommissioning operator that is only defined on a short-term basis. A legal access to resources implies that past generations should have planned financial savings for present generations. In order to also preserve the ability of future generations to resolve their problems of decommissioning, the present generation must make sure that a control and distribution procedure is present for long-term funding. This automatically implies the weight of public entities in settling long-term funding.

Ethics in decommissioning funding raises the question of an existing borderline between private property ethics with the entrepreneurship freedom and ethics in public decision making. But when common good is put forward it is currently only debated on the short-term basis.

2.2 The Market as a Part of the Common Good

Each authority aiming at that common good, that represents the interests of the whole society, would be a basic principle for sustaining decommissioning funds in the long term, instead of leaving the drive of managing our health and public taxes to the industry. Another question is how to recognize common good and define it when other partners feel free to justify their own assessment procedure and their own rights on a long term basis.

The common good must represent the stockholders' agreements in a sector-based policy but it also has to go beyond their momentary needs. Whether it deals with the market or public authorities the common good allows the aggregation of preferences and the opportunity to present results "as a whole". The ethical basis, however, is drastically different because talking in a market context, common good, in a certain policy, can be reduced to the cost of kilowatt/hour or to questioning the protection of acceptable health levels in the case of State intervention in the management of interests which are external to decommissioning procedures.

It would, however, be overemphasized to equalize the market with the regulation mechanism of the common good. Could we then easily assimilate sustainable economic development with "the" common good? Moreover, even if we wanted to stay in an ethical economical development approach, maintaining environmental protection could then be used as a "resource" in a long-term economic development. Seen from this point of view, financing decommissioning is not just an external cost to be internalized but becomes a corollary of sustainable development. The Nuclear Energy Agency (NEA) recognizes [9] the necessity to evaluate the external costs, in a variety of examples of countries

and the long-term effect on environment and health: “Externalities of energy are of course not limited to environmental and health related impacts, but may result also from macro-economic, policy or strategic factors not reflected in market prices, such as security of supply, cost stability and broad economic impacts on employment and balance of trade.”

Accepting, however, such a basis to elaborate financial ethics shared on an international level assumes that efforts have already been made for an ethics of fairness. This supposes some values have already been shared by the majority of the stakeholders who aim at building up a common framework of debates.

Indeed, certain tension may exist between the Western Philosophy of Equity and the economic market. The definition of equity in common property asks for a particular philosophical approach. As maintained, the utilisation of the concept of equity in the concept of the common good seems to be quite risky for a correct comprehension of the concept of equity in funding management.

2.3 The Public Interest as a Part of the Common Good

In the hands of public authorities which want to legitimate their position, the common good is undoubtedly used as a tool of long-term governance. In particular in decommissioning, the reference to common good could both mean imposing the obligation of operators to allow some levy on their benefits and to involve the citizens as tax payers to contribute to this funding.

Thus there is no use speaking about a common good without a more formal and specified framework for its application. We want to stress that the traditional dualistic approach between the public interest and the common good could be of less importance with regard to decommissioning funds: The burdens and the benefits will be parts of our common heritage in both cases. The only difference consists of giving more importance to their weight, either in favour of the governmental bodies or the regulation by the market. To focus on the dualistic approach between weighing customers vs. tax payers puts in the shadow the importance of how the energy producer might stay a responsible partner for the burdens of the past. One accepts that transparency in decision making leads to the acceptance of a debate on the involvement of different groups to pay the bill for decommissioning the nuclear power plants. But using the need for transparency for that purpose seems unethical to us. These amounts must at first ensure securing financial feasibility in comparison with safety goals expressed in the present or in the past. Today modifications are made to environmental standards and to the acceptance of industrial risks. New technologies are not considered as part of a continuum of progress where public welfare is growing up automatically. Indeed, other social concerns come forth after several accidents and catastrophes to demand advancement of technology on a large scale.

The definition of the common good then awakens the delicate question of knowing that one can easily turn the definition of individual good to collective good. The market brings an answer to this question by equating its own regulation system with the aggregation of individual preferences coming from social requests. This would suggest that we transform common good to measurable units. But it neglects that goods cannot be so easily measured or taken in charge by the market regulation. Not all goods may be defined and available by the market. Rival consumption in electricity and energy provision is not sufficient to determine either security or what the common good is. Regulation mechanisms in the long term and political values have to interfere with them. Therefore, the management of decommissioning must take care of less technical questions like the opinion of nuclear site neighbours or the importance of dialogue and further stakeholder involvement. The NEA has also

developed a more integrated approach in ethics, expressed by representatives of the population and representatives from the authorities who introduce a larger ethical vision of waste management [10].

The communication process should not be seen only as a one-way vision of information towards the general public but rather like an organised framework making it possible to take into account the opinion of the stakeholders in the production of results and in the enforcement of the related standards. Such a process finally enables to take decisions which are based on a stronger social legitimacy. This openness of the process to more social interaction leaves more open questions about the relevancy of social arguments that could cut enormous investments injected into the nuclear engineering, technology, options for sitting and decommissioning scenarios. The integration of the acceptable externalities of nuclear energy costs is at stake: Even the Nuclear Energy Agency has some difficulties to make them visible for the current generations. Sometimes it seems the existence of the problem still depends on the capacity of some stakeholders to face the need to make sufficient provisions and at the same time to show the topicality of their problems.

In 2004 the NEA [10] said: “Public involvement, at the earliest possible stage, is perhaps the most vital requirement, although it will not necessarily be enough. The public deserves and should have our respect. We cannot expect their trust if we do not trust them. Without them we are lost. We must include the economic dimension in our communication programs, including setting out the funding methods that will ensure that costs will be met when they incurred, which may well be far in the future.”

This discussion is to know what is necessary in order to achieve decommissioning from which the community will profit. Just as when pensions enter into competition with the next generation's health level, it should be known where the public interest is. This will help us to set the priorities to ethically respond to some tensions between the protection of individual rights and the rest of the community. It also shows the importance of writing down international guidelines for such complex problems where rationalising should be decided in a process of mutual comprehension and consultation for deciding a logical outcome for mutual welfare. An unethical attitude would consist of deciding what is fair and ethical only in the biased framework of the decommissioner's interests.

The concept of “public interest” adopts a different meaning when we realise that it limits the extent of the common good. With “public interest” we recognize that there is a clear need to make the scientific data more transparent and public. We may still speak about shared interest, which means also an interest in common, but with another meaning that changes the management of knowledge, that requires more public access to different kinds of information and, finally, that prevents the expertise process from being led by the current dominant positions of the strongest stakeholders.

Ethics must help us to improve the conditions of a better knowledge management and lead us to make the distinction between what is considered as the utility of the State and the interest of Society as a whole. Democracy cannot be used as a given reference that will get the acceptance by everybody: It must show it and we think the Information Technology supports can help to improve the public access to scientific information. This technological deal of information is in a way a “non-political” approach to state the fundament of a policy, instead of fighting from the very beginning with ethics, out of the blue.

Applied to decommissioning funds, this will help us shed light on the distinction of State intervention as a manager, a controller and the source of funding. The responsibility of taking the long-term safety operations into consideration would also clarify ethical answers by making the difference between private operators and administrative bodies who are not directly legitimised by votes or political mandates.

So nuclear energy production and industrial interests which are tied to common interests allow an economic development in benefiting countries. But the protection of private interests and the management of funds may generate decisions that are totally different as compared to their having been for public interest. The importance of the funds concerned, the example of financial scandals within private multinationals in the energy field, the difficulty following security measures without the need for deep scientific knowledge and the difficulty of protecting human health on a very long term basis, all this has to face the economical pressure. This implies the importance of keeping the public interest above the short-term benefits, for controlling the decisions of different spokespersons. Democratic justification must then interfere with the respect of individual values and not be blindfolded like the market.

2.4 Measurement Units of the Common Good

The financial availability of funding, the relevancy of exporting certain technologies, the choice of technology taken in the past, or the choice of a depository on the surface or geological ... all come into the equation to assess the “right” amount of money for decommissioning provisions. Debating and finding the balance between the various interests that have to be taken into account raises the question of what are the key elements, and what legitimates the process of designating what is regarded as “the criteria” themselves. Then, the criteria of decision themselves become an element of discussion and tend to be mastered by the nuclear field itself [11], which is an easier framework of debates among involved stakeholders, than trying to enlarge the rationale of the amount for decommissioning to the whole society. In a way, democracy wouldn't have to ask to the nuclear field to take the responsibility of debating of their interests on a large scale.

The solution would never emerge by cutting nuclear power from the rest of the world and even less by trying to find an ethical or logical explanation that would be solely related to nuclear waste or decommissioning. If decommissioning and the provisions at due time are needed, we will have to seek for a better clarification of the social priorities which are hidden in technical solutions. In short, to consider sector-based policy, as a management guideline against social conflicts, can only lead to adopt a type of ethics and technocracy's vision to legitimate the imposition of a comfortable technical issue towards the rest of Society.

One of the ways to measure the common good would be to take into consideration solutions proposed by experts and technicians leaving aside the possibility of debating other views. Their solution would be a deal for other partners who would be forced to adopt their beliefs making the needed sacrifices in regards to the social good. This would imply ignoring immediate possible investments with regards to other priorities. Nevertheless, a technocratic policy would not be relevant for a starting point without implication on organisational principles for decommissioning funds.

No scientific standard can hold any definition of an acceptable frontier enabling the passage of decommissioning operations of a nuclear plant to further consideration on the needs of the population in the long term. Conversely, social and political debates in governmental bodies are not framed to reverse priorities defined by experts once they have adopted their decision on methods of the decommissioning.

In order to identify a criterion that helps us define common good does not necessarily guide us through the process by which such a criterion has been defined. Nor does it show us who the stakeholders are who have to take the initiative to build up agreements on a financial basis that would be accepted as sufficient for the funding.

The definition of a legitimate criterion to frame the common good, which helps us to set a levy for provisioning these funds, is not the privilege of a given stakeholder group involved into the decommissioning process. Nor is it only the one of an elected audience that might already have a democratic legitimacy. In summary, a sector-based policy of nuclear waste or, even more specifically, in decommissioning, cannot come from the nuclear field itself but from the rest of Society. It only may come from the process that allows us to speak about common good. This is a shared idea where all these varied interests are discussed within an open group debate. We now have a better idea of the need to define what we could embrace as ethical concerns before starting to look for its application within a political concept, such as common good or public interest.

3. FAIRNESS AS A SPOKESMAN AMONG CURRENT AND FUTURE GENERATIONS

3.1 Equity Refers to Fairness and Distributive Justice

What are the qualitative criteria of fairness that allow us to justify the choice of resource allocation either compared to a given market structure or in the distribution of benefits and burdens related to dismantling?

Following M. Maiese, [12] the distributive justice “is concerned with the fair allocation of resources among diverse members of a community (...). Because societies have a limited amount of wealth and resources, a question arises as to how those benefits ought to be distributed. The common answer is that public assets should be distributed in a reasonable manner so that each individual receives a ‘fair share’.”

Because the theoretical approach of distributive justice thus means less immediate application, the question of the manner in which institutions will be charged to set up this justice is set aside. This brings us back to the question of organising the debate on how to define ethics in a practical way.

3.2 The Need of Institutions for Questions on Ethics

The setting up of the decommissioning funds requests an organisation that clearly states its ability to represent the interests of the current generations. Such an organisation must avoid monopolising the whole procedure that answers completely the sum of interests of its individual members [13]. Moreover a sound management of the funding will undoubtedly take into account the burdens of the past, but, above all, will prove its ability to establish good conditions for dialogue, like transparency in the decision-making process and its ability to offer productive definitions of well-being for the next generations. Setting rules in fund management is only done in an efficient way if based on a large social agreement keeping in mind the embedded values.

The decision-making process must represent varied and diverse interests through generations. This implies that sufficient representative mechanisms assure the balance between varied interests in Society and that their outcomes are regularly re-examined. But this process of “social assessment” must avoid giving excessive importance to the independence of the procedure itself. This precaution is valuable both towards the choice of too stable values of justice and investments approved in reports of experts.

To approve some ethics on the long term might create an “island” within Society without giving the right to the future generations to take part into the debates and to use their knowledge. A stable

bridge must remain within the population, seen as a sum of people who deserve individual protection, and the institution whose role is to defend their rights. In the same way, scientific knowledge could be misused to the greatest advantage of financial institutions by the acknowledgment of a very stable organisation that would be in charge of the fund management. Therefore, there is a clear need for control and debates regarding its use. This will enable the social justification of the cost structure that would sustain the position taken by both scientists and other stakeholders.

This also raises the question of whether it would be better to found the provisions on democratic institutions or to erect them by administrative bodies [14]. The idea of calling upon democratic bodies to solve the problems will mainly help to avoid the dominance of public monopolies or private trust. But enlarging the scope of debate on decommissioning funds will also raise the risk of divergent interpretations of the common good. The split of scenarios with numerous options for the use of decommissioning funds would also weaken the guarantees for their availability at needed times.

In other words, whether it be ethics of public authorities or only based on a peer-review by scientists, ethics would have to fulfil the requirement of having an ad hoc organisation that could legitimise the “right” form of fund management. Only ethics that depends on a more transparent democratic decision-making process could reach this goal.

3.3 Moving Towards an Ethical Transfer of Burdens Between Generations

Today’s generation must resolve a key problem, whether to keep or not the nuclear option. It is confronted with two problems. On the one hand, the costs of decommissioning cannot wait indefinitely for a debate on the heritage of nuclear waste, with regard to the public opinion. On the other hand, one must also integrate decisions in our current political agenda to provide sufficient funding for decommissioning. The conclusion is simple: The current generation has to pass a part of the burdens to the future generations.

We could see this situation as unfair [15] for the following generations because they will not profit from the nuclear energy as we do, but will have to pay. At the same time, in terms of distributive justice, we could consider as fair, the need to balance the burdens on the following generations instead of asking the current generations to solve the problems for the previous ones. We have to accept that the future generations themselves also have to take into account our current production of nuclear waste to avoid excessive burdens today. But is it ethical to accept to preserve our financial resources and leave to the following generation the need to take charge of the financial weight?

4. A FAIR TRANSFER BETWEEN GENERATIONS

4.1 Justice for Which Generation?

An equal approach between the generations implies that the growth rate [16] of this generation and future generations may not suffer any longer from the former generations’ attitude which consisted of externalising production costs on successive generations. We then come to a paradox. A more equal distribution of burdens between the current and the next generations leads to a diminution of financial resources for the current generation. We tend to put the burdens on the future generations by making a comparison with the current generation to the one contemporary with the first nuclear power station. The consequence is that when we talk about protecting the current generation – which is also the most financially exposed – we decrease available resources for future generations, just by starting to think about the safety for the next generations. In other words, the future generations will

have a low savings rate because of our including them in the scope of our ethical guidelines to support the costs of the past.

Another paradox would consist in believing that an ethical approach amongst generations, based on the attitude of past generations, would lead the present generation to take fewer measures to assure the financial feasibility of decommissioning. The question is to know what would be the “ideal” financial burden to pass over and also what would be the ideal benefits and whether it would be necessary to link the benefits to the nuclear energy production span. The ones who get the benefits would then also be the ones who have to pay for it.

We have to be more cautious when identifying the generations that have taken all benefits from the sale of nuclear energy and from all kinds of nuclear activities. We have to keep in mind the clear link between these services and the costs of decommissioning activities [17]. Maybe, this would be clever but useless to find the current responsible of financial safety by looking at the beneficiaries: The previous generations are gone. The ones who might be seen as financially capable are the present and the future generations. This is quite easy to find the money in the generations that have to pay, without regard to the benefits of energy use. But only the past and present generations have benefited from previous usage of past nuclear energy production. Above all, the following generations will have to face the risk of exposure to radiation when decommissioning operations, in case of wrong dismantling or weak counter-measures.

The stage of development of each generation may then be used as a reference to know the standard necessary to help the future generation. The long run in the management of nuclear waste, but short term for decommissioning, imposes the necessity to revisit the modes of managing resources of several generations. Putting this model at stake leaves room for a distributive justice that is decided for future generations by the present generations. Each generation concerned can find itself in a crisis situation, such as deciding that it gives themselves the right to sacrifice their resources generated by past generations (to pay the pension with decommissioning funds) for the benefit of future, who will then have to make the effort of financing and to continue allocating resources for decommissioning [18] But on which base is it ethically acceptable to impose such an effort on the following generations: Utility of the present generations or egalitarian approach between the past, present and future generations ?

Utilitarianism: A Varied Set of Definitions for Utility

Some philosophers, usually mentioned as the founders of the utilitarian theory like J. Bentham and J. Mill [19] stressed that in a utilitarian approach: “All action should be directed towards achieving ultimate happiness for the largest number of people. We are then far from the different theoretical concepts that have been written after on to legitimate the market rules. Nothing, in utilitarianism, forces us to think that only the preference of a consumer expresses the representative happiness of the whole group from where it originates”.

Even in the case of “the” market utility we can imagine that we can change its content depending on the market evolution. Management of these funds by the State or under the control of waste managers may show at first the opposition between public intervention and the private market sector. Nonetheless, it is possible to speak in both cases of utilitarianism from both angles. The market can then recognize different options that would represent social utility.

We can then define utility as a value which is measured by the standard of the greatest advantage for everyone when it represents the maximization of overall utility for the group. But this concept of maximization does not mean there is no question about the definition of social values and public interests. The regulation of the market also has to recognize transverse dimensions, such as

environmental protection, when evaluating decommissioning costs. “Utility” is not only defined by the market but may also reflect social values. Applying utilitarianism to the decommissioning costs then means defining what is the maximisation of the public welfare of present generations.

The previous ethical ground called “polluter-pays principle” is not sufficient. Indeed, it has been built on the utility of the free enterprise and the limitation of its abuse, by the State. The funding managers’ main concern today is the provisions of these funds, its use and control. In a few words, the utility of decommissioning funds needs safety in finances for the long-term. But the advantages of industrials are not sufficient any more for defining the welfare of the future generations. Society is looking to the availability of a warrant that is able to take in charge possible failures of the private system of funding. Making waste producers and decommissioning managers responsible for health and environment in the long run will not be sufficient to sort out the problems of intergenerational ethics. Industrials themselves need to get the support of other stakeholders to reassure their investors. The limits of provision from the private and intergenerational ethics call for a better responsibility of national and international public authorities.

The need for Society to be in charge of the financial burdens raises the question of the legitimacy of its structure in a right institution. We ask the question whether the confusion may stay, from an ethical point of view, between the responsibility of the owner of the waste and the financial responsibility of the management of the decommissioning funds. These managers, or at least the management system of the funding, must then have a longer life span than the funds. With no doubts we must link utilitarian ethics with long-term governance ethics. The utilitarian approach raises the question of knowing the right conditions for acceptable feasibility: What are the savings to be adopted by financial institutes; what are the appropriate social uses that may be acceptable for provisioning the stock or to recapitalise interests.

4.2 Egalitarianism: What Is the Balance Between Generations?

The egalitarian approach can be applied to favour different logical actions in the management of public budgets that vary from decommissioning funds, such as public roadwork or better education in primary schools. Today, the expert must meet the decision-makers to set hierarchies between different types of utilities, not by taking the responsibility of the political mandates, but using their knowledge to give clear assessments of the costs. This helps politicians see what are the consequences of each decommissioning option for the present generation. The utility must not only be defined by the nuclear energy producer but must result from a network that produces public information. Utilitarianism does not mean favouring only the companies that have sold the nuclear energy or are in charge of managing the funds: Speaking about utility may also open ethics to the precaution of the future generations.

Let us define an egalitarian approach like a fair distribution of benefits and burdens among generations, but the fairness is here found in an equal treatment with regard to a common criteria, like the same capacity of payment, the same consumption of energy, the same right to be protected from radiation, etc. We may also take into account other criteria, like similar life standards between the rich and the poor countries. Other scenarios are also possible, like a solidarity mechanism between national and international levels.

A fair approach enables characterizing the needs of everyone with their own history, to justify these differences. This is about a proportional answer compared with the needs. The egalitarian approach then refers to the similarity of situations that calls for a similar response, which is different from adopting a common criterion to all. In other words, an egalitarian approach implies a debate

between different values in Society. It does not aim at protecting, in the decommissioning costs, a unique rational criterion from some cost assessment methodologies.

In order to assure an effective application of an egalitarian approach to the fundamental rules and management of funding, we simultaneously have to think what the consequences are on the different actors involved in the decision-making network. We then can examine the different technical steps from the decommissioning operations up to the questions of the different types of risks that may be taken in stock exchange and how accumulated interests might be used.

An egalitarian approach to future generations will be possible when a precautionary approach to funding management is applied. We could also add that an egalitarian approach would enable equivalence between local populations which live in richer countries and poorer ones. Within this approach, preventive measures against bankruptcy, planned by decommissioning operators, or by the public management, will then be put into balance with regard to other financial mechanisms that have a larger scope at an international level.

Another way to apply an egalitarian approach would consist of distributing the financial burdens on a large number of generations (only on those who benefit from nuclear) in order to compensate the lack of provisions from the past, but from the very start of the nuclear power plant building. Then, benefits must also be dealt equally among the generations, which raises the issue of the rationales for the distribution: Do the next generations have to adopt the same standard of life as the previous ones? The egalitarian approach must therefore be applied in order to make the transfer of the burdens feasible and therefore also keep in mind the importance of passing on knowledge. Indeed, the evaluation of the costs and of the funding might then be regularly revised to take into account the current progress in costs assessments.

The accumulation of knowledge therefore has a huge impact in an egalitarian approach on the burden of decommissioning funds. In the same way, the capitalisation of interests may also influence an egalitarian approach between generations for all stakeholders who are seen as responsible for the management of these funds. One of their responsibilities will consist of bringing to debate essential needs that must be satisfied by the present generations. We then have to re-consider the egalitarian approach by taking into account the evolution of the social needs in a progressive manner and not to rule out the definitive definition of what is equal among the generations [20].

Ethics based on egalitarianism could also be used to justify financial safety in decommissioning options adopted when setting the foundations of these funding. The equal approach is defined by the possibility to reassure investors of current nuclear technologies. This would show to them that their finances are protected against other industrial sectors. The different industrial technologies are then compared by showing a common and equal approach in all decommissioning options. We are then able to build internal coherence in this sector with the help of a fair and balanced funding management.

Applied to management funds, an egalitarian approach would then enable to place all generations on the same level, from the start of the nuclear power plants, up to the decrease of radioactivity levels. The egalitarian approach puts forward an ethical discussion based upon proportional factors among different values and open doors for knowledge management and democracy.

5. CONCLUSIONS

5.1 Ethics and Knowledge Needs Each Other

Ethical guidelines with regard to decommissioning funds show interactions between representatives of the present and the future of our society and other stakeholders who deal with the complexity of knowledge in radiation protection, nuclear waste, environment and health. The distribution of risks and benefits addresses the question of the role of nuclear experts who have to widen the perspectives of their previous practices which referred to a technical approach of decommissioning [21], like for example, to take into account the growth of the population around a nuclear depository.

The decommissioning funds illustrate the need to give to experts a participation in the writing of ethics for the future generations. They become co-mediator, with all other stakeholders of the process of stake translation from each generation. Between intra-generational and inter-generational ethics, the whole process of knowledge management (different shapes possible) can help decision-makers to see where are the priorities with regard to the importance of the amounts to be provisioned. But in a way, by exceeding his prerogatives that are frequently centred on scientific tasks, experts have been asked by other stakeholders to define the future, by integrating a lot of given values, social acceptability of risks and financial capacities.

Of course, this mandate, implicitly given by media or representatives of the population, is at the same time contested when the failures of technology become more apparent. When experts take refuge in the ideal image of scientist, giving some answers on the needs to secure the technical aspects of decommissioning operations, they also avoid to explore the complexity of intergenerational ethics, pushing further the weight of some social responsibilities to other stakeholders. But framing a scenario on the long term necessarily leads to more involvement on their part. It also open questions on other issues like: An acceptable level of life quality, the costs for each generation to secure it, and the liability regime in law.

The “right” decision about the provision for decommissioning funding asks for a role of translators between different fields, not only by experts, but by all involved partners. The evolution of their role in laymen countries may give a feeling of decreasing their prerogatives, firstly defined in their own network. But such a change will be possible when the process of data production and its exchange will also transgress the borders of the process of social acknowledgment. In other words, to meet other points of view deals with a production of knowledge that will necessarily lose its coherence for, at least, one of the partners that is in charge of bringing expert knowledge to a public arena. The process of knowledge and its components are of high importance to give clear limits of responsibilities and facilitate the involvement of the stakeholders. Making it available for all will allow more transparency, more control and interactions with other social logic, rather than maintaining fund management in a technical and industrial perspective.

5.2 Intergenerational Ethics Needs Public Accountability

Intergenerational ethics focuses on a long-term strategy, on solidarity with future generations. Such an ethics favours transparency in the cost structure, a stable regulatory framework and a system of control that will be open for justification principles. Ethics in the long term for decommissioning funds would not confuse the needs for a stable framework with the use and the availability of funds and stability in long-term governance institutions that would escape any social criticism. In summary, intergenerational ethics pleads for a kind of accountancy, not the one which is given by experts or

financiers only, but mainly by more transparency in the decision-making process [22] and involvement of stakeholders at an early stage. Maybe international agencies [23] could at least help in the process of “stretching” [24], i.e. scrutinising, the expert reports and cost assessments. More tasks could also be conveyed to international agencies with regard to international ethics, not only as stretchers of the process, but as the guardians and, in a word, promoters of forums for ethical debates.

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ETHICAL GUIDANCE IN CONNECTION WITH DECOMMISSIONING OF NUCLEAR POWER PLANTS

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Decommissioning of nuclear plants is guided by three different moral obligations. There is, *first*, the obligation to collect and to preserve the financial, technical and scientific resources necessary for the future decommissioning of nuclear power plants. There is, *secondly*, the obligation of the responsible authorities in charge later in the present century to protect dismantling personnel, the general public and the environment from excessive risks and, particularly, harmful levels of radiation. And, *thirdly*, we in the present generation and the next one implementing different decommissioning programmes are morally responsible for doing it in such a way that future generations of human beings are protected. *The main purpose of this paper is to discuss some ethical questions in connection with the third type of obligation.* I will suggest some of the ethical principles involved. These principles are indirectly relevant for the other two obligations. Needless to say, one of the reasons for the collection and preservation of resources for D&D programmes *in the first place* is our obligation to protect future generations. *How* these resources are collected and preserved is *primarily* an entangled web of financial, technical and political issues – albeit that usual legal and ethical considerations apply.

The main point of departure will be a paper delivered by Kenneth Arrow at the IEA World Congress in 1995, “Intergenerational equity and the rate of discount in long-term social investment”. In this article Arrow discusses the ethical arguments for and against so-called “pure time preference”. He concludes that the present generation has an obligation to protect future generations, but the present generation also has certain obligation towards itself. But how do we strike a proper balance between the obligation to ourselves and the obligations to future generations? My paper is designed to provide a tentative answer to this question.

My argument will be developed in ten steps. Except for the first and – possibly – last step, they are controversial and have been contested. Nevertheless, I will argue that there are certain arguments in their favour.

1. *One central characteristic of environmental problems and the policies to deal with them is the long time horizons.* Long time horizons are required to deal with, for example, climate change, species extinction and disposal of radioactive waste. Also the decommissioning of nuclear power plants has a long time horizon and might well start 50-60 years after the plant became operational. This time horizon is outside the range of traditional economic and political decision-making. Corporations and governments normally look 5-10 years ahead, not decades and certainly not centuries. The tension between our measures to handle environmental problems and our traditional forms of decision-making is accentuated by our obligation to protect future generations and provide the safe and long-term disposal of radioactive material (for example, the reactor tank) from the dismantled plants. Here the decommissioning programme overlaps the programme for a safe disposal of spent radioactive fuel. And time horizon for such programmes dwarfs almost all other environmental concern.

2. *The principle of general equity is relevant for programmes for decommissioning of nuclear power plants.* One of the most obvious is concerns about the equity between the present and future generations – and between future generations. And the ethical presumption is clearly an extension based on the equality of all individuals, i.e. the principle of general equity: all humans should be treated equally – unless there are morally relevant reasons to treat them differently. Gender is not a reason for unequal treatment, nor is race or religious belief. And - writes Kenneth Arrow – “the fact that an individual will be alive at some future time instead of today, does not seem to be a morally relevant distinction”.

At first, this seems convincing. But on reflection, a certain need for qualifications arises. *First*, the principle of general equity is *agent-relative*. Both the other – future generations – and the self – present generation – impose obligations on the moral agent. Arrow quotes the first century Rabbi, Hillel. *Ethical obligations are agent-relative*. “If I am not for myself, then who is for me? If I am not for others, then who am I? If not now, when?” One might also quote one of his contemporary: “Love thy neighbor as thyself!” *Secondly*, the principle of general equity imposes a demand to treat all individuals – and generations – equally *unless there is a difference among these generations that are morally relevant*, i.e. justify a differentiation among them. One such morally relevant difference could be that future generations will be richer and more technically advanced than our generation. If we knew that this was so, the perspective on the decommissioning of nuclear plants and the disposal of radioactive material from these plants could change. If future generations will become richer and technologically more skilful than our generation, it would not be morally unacceptable to let them do at least some parts of the necessary environmental clean-up after our nuclear programme. Needless to say, we don’t know that this will be case. For all we know, future generations could be poorer and less technically advanced than our generations.

Another possible fact of moral relevance is the economic, technical and scientific growth of the present generation. This growth could be regarded as this generation’s primary contribution to future generations. Economic growth and scientific progress relieve us of all other more specific and risky contributions to insecure decommissioning funds – even in the form of treasury bills. Needless to say, we don’t have any way of measuring whether our economic growth or our technical advances cover all the open or hidden costs of our depletion of the environment or exploitation of scarce natural resources. So the future wealth of coming generations is uncertain – as is our own economic, scientific and cultural growth in comparison to externalities. So far, the principle of intergenerational equity stands.

3. *When applying the principle of universalizability it is justified to consider our inability to control the past as well as the long-term future.* Let me make a short digress into the realm of metaphysics to make a more salient point. Why is it that we don’t even consider that the principle of general equity has the implication that we are to treat *former* generations equal to our own and future generations? Well, for all practical purposes, we cannot travel back into past and make justice. We cannot be morally obliged to do something we are not able to do. So we must waive *this* implication of the principle. But an analogous argument can be formulated for generations sufficiently far away *in the future*. *For all practical purposes we are unable to affect their situation*. Are we then relieved from the ethical obligation to treat them as our equals? Yes, in one sense we are; in another sense we are certainly not. I will try to clarify this complicated position.
4. *Time preference-principles amounts to making certain priorities in favour of certain generations.* One example is the idea that *the* present generation should have a priority when it

comes to distribution of certain values. Such present generation preferences have been heavily criticized from – among others – Frank Ramsey. Frank Ramsey was an English mathematician and philosopher in the first half of the last century. He was also a friend of Ludwig Wittgenstein and had a special interest in the philosophy of economics.

In an influential paper from 1928, where Ramsey presented a mathematical theory of saving, he wrote the following:

[I]t is assumed that we do not discount later enjoyments in comparison to earlier ones, a practice which is ethically indefensible and arises merely from the maximalness of the imagination. (Ramsey 1928, p. 261 – reference by Arrow).

Frank Ramsey and others argue against *any* kind of time preference. It is wrong to give our own or any other generations special weight and importance in a moral argument concerning the distribution of that which is valuable. Time preference is a polite expression for rapacity and the conquest of reason by passion. According to Ramsey, the social rate of time preference should be zero (Solow 1974, p. 9 – reference by Arrow).

The problem with this argument is that it is too much of a top-down argument from the general principle of general equity to the absolute equity between generations. We must also give a certain weight to specific facts and what I would like to describe as the basic structure of existence. The irreversibility of time and our inability to influence the future beyond, say, a thousand years from now belongs to the basic structure of existence.

Koopmans and Arrow have given another kind of argument for time preference when it comes to the present generation. It can be construed as a reduction in absurdum-argument against Ramsey's claim that time preference is ethically indefensible. The short version of Koopmans' and Arrow's argument is simply the following. Suppose that we had the unabridged obligation to treat all generations alike. This would place intolerable burdens upon a given generation for the sake of futurity. We would be obliged to sacrifice almost everything we have, and save it for future generations. And our children, our grandchildren and so on, would similarly be obligated to save almost everything for the future. Arrow concludes that "the strong ethical requirement that all generations be treated alike, itself reasonable, contradicts a very strong intuition that is not morally acceptable to demand excessively high saving rates of any one generation, or even of every generation" (Arrow 1995, p. 16). Arrow arrives at an ethical position he calls *discounted utilitarianism*: each generation will maximize a weighted sum of its own utility and the sum of all future generations, with less weight on the latter. Really distant generations are treated all alike. Incidentally, this accords with the outcome of questionnaire studies (see Cropper, Aydele and Portney 1994). Respondents in the general public weight returns one hundred years from now very little more than those two hundred years from now.

5. *Nevertheless, we are obliged to show an equal respect to our own as well as to all future generations, namely when it comes to respect for the principle of minimal justice.* This principle of minimal justice could be formulated in the following way:

Every generation has a moral obligation to use natural resources in such a way that we don't threaten any generation's possibilities for life.

This puts serious and rigorous policy constraints on nuclear waste repositories. The principle of minimal justice implies a virtual absence of discounting. Kenneth Arrow has argued that "even a modest discount rate would assign virtually no weight to deaths beyond a few hundred years".

This is the first place at which ethics has a close encounter with policies for the decommissioning of nuclear plants. According to Ludwig Aumüller, managing director of RWE NUKEM GmbH, there are two routes to the final decommissioning of nuclear plants: immediate dismantling to return the site to a “green field” state, or safe encapsulation for later dismantling. In the case of a nuclear power plant the two alternatives have their advantages and disadvantages, but before a decision can be taken for one or the other there is the so-called post-operational phase after the plant has ceased producing electricity. This involves removing all the fuel elements and operational waste from the plant. Although 99% of the activity will have been taken away for storage, the post-operational phase is dominated by a very complicated operating routine. It is not until authority has been granted either to dismantle or to encapsulate that the operationally orientated regulations give way step by step to those orientated towards dismantling. Maintaining “residual operation” is relatively cost-intensive, and this argues in favour of completing the dismantling process quickly. So irrespective of the route one chooses, ground or underground repositories for radioactively contaminated material from dismantled nuclear plants has to be constructed. Radioactive material must be stored or transmuted in a way that protects human life in this generation and in every future generation alike. Deaths or injuries in a few hundred or a few thousand or a few ten thousand years because of radioactive material from former nuclear plants carry equal weight and constitute an equal loss to humanity. It is not morally just to disregard unnecessary and avoidable deaths and injuries to future generations simply because they are alive at some very distant time in the future.

6. *The primary responsibility for the application of the minimal principle of justice is the generation that produces the pollution which threatens future generations possibilities for life.* This statement is analogue to the PPP-principle – the Polluter Pays Principle. This principle implies that the present generation is morally required to abate the emission of carbon dioxide emission to reduce the climate burden of the future. Similarly, we are morally obliged to protect future generations from the hazards of nuclear waste through a safe and sustainable repository. We have enjoyed the benefits of nuclear power – we are also obliged to pay the costs. I will shortly return to the question how this responsibility could be realized.

7. *In contrast to the minimal principle of justice, the maximal principle of justice must be interpreted in preference for the present and the immediately succeeding generation.* According to the maximal principle of justice we in the present generation have an obligation to use natural resources in such a way that not only the present generation but also future generations can satisfy their basic needs. This maximal principle of justice is clearly – as is the minimal principle of justice – agent-relative. The agent, i.e. our generation, is obliged to satisfy its own as well as the needs of future generations. On the other hand, this maximal principle of justice might be interpreted in a time preferential way, i.e. with a decreasing responsibility towards future generations. Beyond 200-300 hundred years the positive influence of the present generation has vanished to an insignificant level. To be sure, our capacities to influence the persons who live on this planet in around 2300 in a *negative way* are considerable. We might affect them in a major way through a nuclear war or through a slowly deteriorating environment. Some of these destructive changes – possible or actual – are irreversible or almost irreversible.

But what is our means today of radically improving the basic conditions of persons living in – lets say – 2350? Even if we doubled our GNP, increased technological development and scientific discoveries, our contributions to the generations that far in the future might vanish by the performance of the generations in-between. My conclusion is then that the maximal principle of justice applies up until 5-6 generations beyond our own – at the most. And this is about as many generations we can encompass with a stretch of our emotional capacity of empathy. I can clearly have a sense of community with my grandchildren (generation 3 from us),

and even with their children (generation 4). Persons with greater gifts of empathy might even have a sense of responsibility and community with their grandchildren's grandchildren (generation 5). But here we approach some kind of limit at which the positive influence of our own generation also reaches some kind of vanishing point. And so does the application of the maximal principle of justice – for us.

8. *Application of the maximal principle of justice could involve storage of radioactive material so that future retrieval is made possible.* The consequences connected with the second and long-term part of the decommissioning programme is primarily the safe disposal of radioactive material from the dismantled plants. The most important question concerns the nature and construction of the repositories. Will these repositories be part of larger repositories for toxic nuclear waste or transmuted nuclear waste product? If so, will they be constructed in a way that allow for some kind of future retrieval of the material – should a future generation decide to do so? It could be argued that we as a part of respect for the minimal principle of justice ought to respect the autonomy of future generations to make or not make such decisions. They might find the material important to fulfil their basic needs.

There might, however, be a strong argument against a repository allowing for the possibility of *future retrieval*. *Albeit that we should respect the autonomy of future generations, our primary responsibility is to construct a repository that fulfils our obligations to future generations thousands of years from now, i.e. that their possibilities of life should not be diminished through the hazardous radioactive material produced by us. This means that it should be sealed off from the biosphere by multiple barriers – and no compromise should be made for possible retrieval. In a conflict between the minimal principle of justice and the maximal principle, we should go for the minimal principle.*

9. *The principle of intergenerational community complements the principles of justice.* What is the *principle* of intergenerational community? According to John Rawls the present generation – as well as each succeeding generation after us – has three obligations to the following generation. They should:
- preserve the advances our culture and civilisation has made,
 - strengthen just institutions and the institutions that promote justice and
 - transfer scientific, technological and economic growth to our children and grandchildren.

Each and every generation has such an obligation. But – and this is an important but – such a continuing transference of values does not come by itself. Economic growth is a necessary, but not sufficient, condition for such a continuing transference of values. The present and the future need to be entwined by policies, institutions and financially robust systems for – among other things - the realization of a safe dismantling of nuclear power plants. A *chain of responsibility* is required whereby the present generation transfers resources and reasonable obligations to the succeeding generation. Each and every generation has such an obligation, so that they possibly can reach an even higher level of human flourishing.

Kenneth Arrow catches the essence of the principle of intergenerational community:

..no one generation controls the future. Each generation can determine how it will divide its disposable income among consumption and various kinds of investments, public or private. But the next generation will have the same decision. If all investment is short-lived (or, more generally, reversible) then all that one generation can determine is how much capital to pass on to its immediate

successor. That generation in turn will decide what it will leave to the next generation. (Arrow 1995, p. 19)

At this point, the really difficult questions begin. What amount of money is sufficient to cover the future cost of decommissioning? Should already existing decommissioning funds in Europe be forced into a common European “solidarity fund”? Such a fund could possibly have certain advantages, but at the same time be politically difficult. According to certain estimates German power utilities have set aside about Euro 31 billions for the decommissioning of 25 plants, while the French EdF has about Euro 26 billions for the dismantling of 71 plants. These issues are, however, not of an ethical nature, but financial and political problems.

10. *The principle of intergenerational community is especially relevant for us today.* For example, the eleven Swedish nuclear plants now in use are operational for about forty years. The principle of intergenerational community puts obvious constraints on the Swedish as well as other national programmes for the decommissioning of nuclear power plants. The institutions responsible for the decommissioning and disposal funds need to be secured. Knowledge, competence, resources need to be preserved, developed and effectively transferred to the next generation.

Of special importance is securing decommissioning funds in the context of the liberalised electricity market which in all probability will characterise the future. *Decommissioning fund is a key element in implementing the obligations of the present generation towards future generation.* The collection and administration of these funds must fulfil stringent criteria of financial ethics. These criteria include:

- preservation and, possibly, increase of financial resources;
- robustness (independence from a variety of societal, political and economic scenarios);
- transparency (communication of working procedures in a way that is visible and clear to the general public);
- goal-specificity (availability of resources constrained by specific the purposes of D&D).

It is a major task to specify what these criteria imply about the collection and maintenance of decommissioning funds. Such a specification is part of a larger specification of the implementation of our responsibility to future generations, particularly the immediately succeeding generations.

The main objective of this paper has been to formulate the general principles to be applied in connection with policies for the decommissioning of nuclear power plants. I have also tried to spell out the constraints which these principles place on these policies both in the first part of dismantling the power plants as well as the second part of the long term running of a safe repository for the disposal of hazardous material from the dismantled plants. I have argued for a set of principles, of which some display a time preference and some other not. By way of ethical method, I think a top-down method is insufficient. Ethics is more than simply a deduction from the principle of universal equity. Of particular importance for the implementation of our responsibility to future generations is the formulation of stringent criteria of financial ethics and the application on these criteria on the management of funds for the decommissioning of nuclear plants and the subsequent disposal of radioactive waste.



A Practical Application of Ethical Principles: The Swiss Example

H. Maxeiner

- 1 Ethical considerations (EKRA)
- 2 Waste disposal system
- 3 Decommissioning and Waste Management Fund

1 TS on Funding Issues, 5th WPDD-Meeting, Nov 9, 2004

1 Ethical considerations (EKRA)

- Responsibility for defining boundary conditions for radioactive waste disposal lies with the society
- Sustainability: Radiological safety of present and future generations has priority over all other criteria: same rights to the same level of safety
- Justification of (deep) **geological** disposal: Burden of dealing with waste should not be passed on to future generations who did not benefit from the use of nuclear energy
 - But: freedom of future generations to decide on WM questions should be maintained
 - Seal a repository as soon as possible (no burden to monitor or maintain)?
 - Continuous monitoring and access any time (re-dispose, self-determination)?

2 TS on Funding Issues, 5th WPDD-Meeting, Nov 9, 2004



1 Ethical considerations (EKRA)

- Future generations: freedom to specify what is an acceptable risk
 - Current and future state of knowledge
 - Probability of an event and extent of damage
- Planning of a repository: **Reversibility** to be taken into consideration
 - Use of better knowledge by future generations
 - Key feature of monitored long-term storage
 - Must not compromise (long term) safety
 - Retrievability of waste is a (key) part of reversibility
 - Problem: difficult to be reconciled with „final disposal“
- Costs of waste management: „Producers pay“ (now) principle
 - Profiting generation should not pass costs to future generations
 - Sufficient reserves to be put aside by producers



3 TS on Funding Issues, 5th WPDD-Meeting, Nov 9, 2004

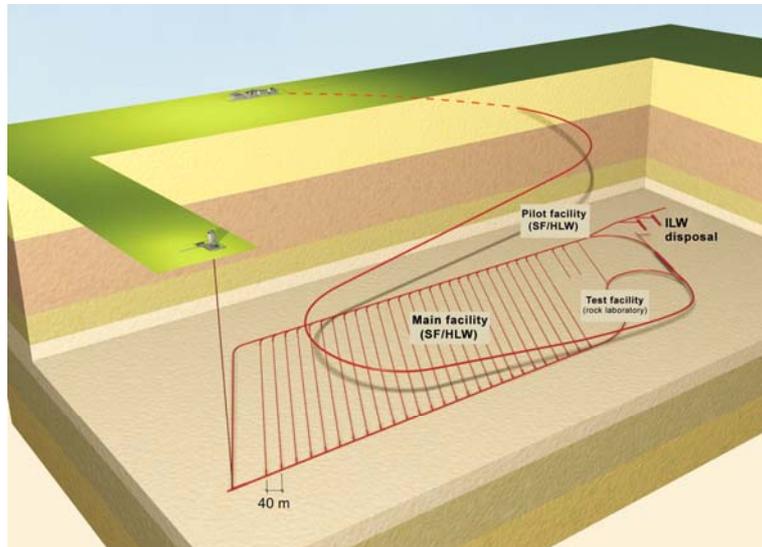
2 Waste disposal system: Geological disposal

- **Test facility** for investigating the suitability of a repository
 - Site specific rock laboratory
 - Operated prior to waste emplacement in main facility
 - Should provide input to the definitive safety analysis
 - In zones planned for future waste emplacement (i.e. on site!)
 - Use of real waste and/or waste simulators
- **Pilot facility** operated before the main facility
 - Spatially separated from the main facility
 - Can be operated over a long time period (representative waste)
 - Monitoring of natural and engineered barriers
 - Check of retrieval of waste
 - May be closed later than main facility, decided by fut. generations
- **Main facility**
 - Retrieval remains possible
 - After waste emplacement caverns are backfilled immediately
 - Monitoring phase: access shafts... remain open
 - Monitoring phase: may be several decades to (more than a) hundred years



4 TS on Funding Issues, 5th WPDD-Meeting, Nov 9, 2004

2 Waste disposal system: HLW/SF



nagra

5 TS on Funding Issues, 5th WPDD-Meeting, Nov 9, 2004

3 Decommissioning and Waste Management Funds

- **Financial means for radioactive waste management**
 - Secure financial means today, independent of economic climate
 - Cover all sorts of waste and procedures
- **Decommissioning fund: Costs for**
 - Decommissioning and Dismantling
 - Conditioning and disposal of decommissioning waste excluding SF
- **Waste management/disposal fund: Costs for**
 - Managing operational waste and SF
 - Waste disposal facilities until closure

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6 TS on Funding Issues, 5th WPDD-Meeting, Nov 9, 2004

Session 2 – ACTUAL EXPERIENCES OF FUND SETTING AND MANAGEMENT

OVERVIEW AND COMPARISON OF INTERNATIONAL PRACTICES ON FUNDING MECHANISMS

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1. INTRODUCTION

1.1 Background

Although the Funding Mechanisms of Decommissioning and Dismantling (D&D) of Nuclear Power Plants (NPP) has recently gained a growing interest¹, this is not only a new but also an old issue.

The issue is old because National Atomic Laws and/or other Nuclear Legislation recognized the mandatory character of D&D. Consequently accumulation of funds to cover the future D&D expenses is a legal requirement since the beginning of Nuclear Energy Industry, at least in countries with a market economy. The issue is new as well because many of the large commercial NPP may reach the end of their lifetime during the next twenty years². As a result, the growing interest on D&D Funding Mechanisms is justified since the funds accumulated should cover the related expenses if any.

Despite this growing interest, there is however a lack, at least at the NEA³ level, of an updated survey of existing Funding Mechanisms⁴. Because Electric utilities are experiencing deregulation movement⁵, there is also a lack of a “comparison framework” which take into account this new context, and within which the effectiveness of current Funding Mechanisms could be assessed.

1.2 Purposes and Challenges of Funding Mechanisms

In the field of NPP decommissioning, funding mechanisms refer to the overall process of financing future D&D operations. Therefore, one can expect a funding mechanism to organize some relevant functions regarding D&D financing. These functions are, 1° the recognition of the liabilities and the estimation of the related financial burden, 2° the collection of the corresponding financial resources 3° the management and disbursement of those resources when needed. In fact, the

1. See [1], [2], [3] & [7].

2. In the case of France, the operational lifetime of NPP has been extended to 40 years. Given this assumption, the bulk of NPP retirement will occur between year 2017 and year 2030. A peak will be reached in 2020 since 7,3 GW capacity will be retired (see [4]). It is worth noting that it could be of economic interest to extend the lifetime of NPP, provided that investments to meet safety requirements are not prohibitive.

3. OECD/Nuclear Energy Agency.

4. The most recent work published by the NEA on the subject with the objective to provide an international framework on a comparative basis is the 1996 report. See [8].

5. See [4] & [5].

mandatory character of D&D suggest that an effective Funding Mechanism should provide availability of funds. This is to say the funds collected should be managed in a consistent way regarding their protection against financial insecurity. Since there is no investment without risk, availability of funds is properly a matter of degree. Therefore the challenge faced by Funding Mechanisms will be to provide when needed the degree of availability necessary for their effectiveness. But this can be expected only if the risk taken in the investment of funds are properly identified and appropriate measures to cope with identified risks taken.

1.3 Objectives of the Paper

This paper will shed some lights on Funding Mechanisms in OECD countries. First of all, it will review and evidence the variety of the institutional frameworks of Funding Mechanisms. Despite existing differences, these mechanisms are set up with common objectives which are, 1° the management/control of the funds and, 2° the bearing of one of the back-end liabilities of nuclear power industry. Therefore, the paper will address the existing relationship between these two objectives.

The deregulation of the electricity market has created a new situation where electric utilities including NPP owners have entered a volatile era⁶. This raises a new question concerning the robustness of Funding Mechanisms. That question is: What degree of availability of funds accumulated could be expected from those mechanisms under these new volatile business conditions? In this respect, the paper will assess the merits of current Funding Mechanisms.

1.4 Methodology

The paper will proceed as follow: 1° **A survey of practices in different countries.** The design of Funding Mechanisms will be considered and their variety will be evidenced; 2° **Respective merits of Funding mechanisms regarding the availability of funds in a deregulated electricity context.** In this respect, the strength and weakness of current Funding Mechanisms will be assessed regarding the protection of funds against financial insecurity. Evaluative criteria related to the design of funds on the one hand and to the deregulated electricity context on the other will be considered.

2. INTERNATIONAL OVERVIEW OF INSTITUTIONAL FRAMEWORK

The objective of funding mechanisms as stressed above is to finance the future decommissioning costs of nuclear power plants. Despite this common objective, significant differences do exist between funding mechanisms in OECD countries. In fact, the overall decommissioning process is subject to national decommissioning policy which are varied⁷. Because of the lack of uniformity of national framework, it seems obvious to expect differences regarding funding mechanisms. It is also of interest to evidence the existing differences. One way of doing this is to look at, and describe, the details of the design of a funding mechanism. This can be done through three steps. The *first* step will consist in outlining the basic components of the design of a funding mechanism. It will appear that those components can be, and are, defined differently. Because there is no single way to combine those components, the *next* step will highlight the diversity of current

6. The concerns here are: 1° electricity market price volatility, 2° cash-flow and economic margin volatility, 3° stock prices volatility, ... See [13] and [15].

7. See the NEA 2003 report ([9], page 21). According to this report, decommissioning policy “refers to government policy, and includes all governmental (national or regional) choices, as described in laws, regulations, standards and mandatory requirements that will influence the framework in which decommissioning takes place”.

funding mechanisms in OECD countries. Respective national framework also address the allocation of the technical responsibility of decommissioning on the one hand, and of the ownership/control of decommissioning funds on the other. The *third* step will then address existing relationships between both responsibilities in order to emphasize the way they are brought together in national framework.

2.1 Basic components of Funding Mechanisms

Four main components of the design of a funding mechanism can be distinguished. These are 1° the costs estimation rules and liabilities calculation, 2° the collection of the funds and its timeframe, 3° the management/control of the funds collected and, 4° the monitoring of the process.

2.1.1 Costs Estimation Rules and Liabilities Calculation

The knowledge of costs is a prerequisite of any financing purpose. So it is in the field of decommissioning where funding requirements need to be determined. For this to be done, the nature of decommissioning costs needs to be defined. The IAEA⁸ standards on decommissioning are the admitted references on the subject within the civilian nuclear energy profession. Therefore, the costs which we need to know in the purpose of funding requirements are costs related to the three decommissioning stages acknowledged by the IAEA⁹.

According to the NEA 2003 report, decommissioning costs can be estimated in a reliable way since decommissioning industry has matured and gained experience¹⁰. However, estimation techniques are basically projection of costs. Therefore, the reliability of costs estimation may be confronted to uncertainties when there is a lack of information¹¹. In contrast, when past experiences of the decommissioning of other nuclear facilities are available, they offer the opportunity to scale down or to scale up the corresponding expenses on a case by case basis.

In OECD countries, decommissioning costs projection rest on two main rationales. The *first* is the **construction costs** of the NPP. This rationale considers that decommissioning costs will represent a percentage of construction costs (between 12 and 20%). The *second* rationale is **overnight costs** which refers to what the costs will be if decommissioning could take place instantaneously according to a defined plan and under prevailing technological and regulatory conditions. It is worth to mention that whatever the rationale is, costs estimates are periodically updated to reflect current decommissioning strategy, the state of decommissioning technology and inflation rate.

Table 1 below evidences the variety of practices regarding costs estimation rules in OECD countries.

Some countries have chosen to base their funding requirements on the **construction costs** of the NPP.

8. International Atomic Energy Agency.

9. It is interesting to recall the respective stages of decommissioning operations. The *first* stage includes removal of all the fuel from the reactor, removal of the waste produced during the operation phase and still present on site, disposal fluids, and some decontamination operations. The *second* stage consists in dismantling the equipment outside the nuclear island and in reinforcement of the reactor containment. The *third* stage consists in actually dismantling the facility. See [14], page 425.

10. See [9], page 46.

11. The consistency of costs estimation methods are not discussed in this paper. The reader should refer to the contribution of Söderberg & al. in this Topical Session which highlights some major uncertainties.

The construction costs rule is applied in Belgium (12%), in France (15%). To cope with the same issue, other countries rely on **overnight costs**. This is the case in the United Kingdom, in Switzerland, etc. In some countries, costs estimates may rest on specific rules (costs escalation or specific assumptions, etc). These countries fall in the category **others** shown in table 1. In Canada, for example, there is no general rule. The owner of NPP are supposed to propose an estimate of D&D costs to the Canadian Nuclear Safety Commission (CNSC) which may or may not validate the proposed estimates. In the USA, the amount of the costs estimation by the NRC is at least \$290 million and \$370 million (in 1999 dollars) respectively for a generic PWR and for a generic BWR¹².

Once the projected decommissioning costs is known whatever the method used, the next issue is to determine the amount that should be really set aside. This is a matter of discounting technique, and within it, of the importance given to the timing of decommissioning activities. It is worth noting that the rationale of discounting is that of accumulation. This means that an amount of money set aside today can grow (free of inflation) in a large amount in the future provided the period is long.

Because decommissioning expenses are incurred several decades later, even in the case of an immediate D&D strategy, the use of discounting seems to be justified, without being mandatory, in decommissioning financing. This is why two methods of liabilities calculation are distinguished. These are the **net present value** and the **current value** methods.

The **net present value method** takes into account a discounting rate and an accumulation period which may or may not include the timescale of decommissioning activities. According to this method, the owner of the liabilities is required to set aside only a fraction of the costs estimates. The remaining fraction is expected to be raised through the accumulation process regarding the discounting rate applied and the accumulation period chosen. This method is also known as **discounted liabilities methods**.

In Belgium, the estimated burden is discounted by considering the lifetime period of the plant and a rate revised every five years. This rate was fixed at 8,6% in 1999. France and Germany also considered the power plant lifetime period and discount the estimated burden at a rate of 5% in France since 2003 and 5,5% in Germany since 1999. Discounting is also applied in The Netherlands by URENCO (2%) and the Research Center (7%). In the UK, the time scale of decommissioning activities is the period considered in discounting. That period is 80 years for British Energy and 135 years for BNFL¹³.

In the **current value method**, the liabilities amount is **undiscounted**. Consequently, the owner of the liabilities should set aside the amount of money corresponding to the costs estimates. In Japan for example, the annual contribution is determined in a pro-rata basis regarding assumptions on the electricity output each year and during the lifetime of NPPs. In the remaining countries in the table below, the financial burden of D&D is not discounted. Table 1 below summarise the current situation in some OECD countries.

12. See [14], page 378.

13. See Annual report of both companies.

Table 1: Costs estimation rules and liabilities calculations in some OECD member countries

Countries	Costs Estimation Rules			Liabilities calculation	
	Percentage of the construction costs	Overnight costs estimates	Others	Discounted	Undiscounted
Belgium	X			X	
Canada			X	X	
Finland		X			X
France	X			Since Yr 2003 ¹⁴	Before Yr 2003
Germany		X		Since Yr 1999	
Italy					X
Japan		X			X
South Korea		X			X
The Netherlands		X		X	X
Spain		X		X	
Sweden		X		X	
Switzerland		X		X	
UK		X		X	
USA			X		X

Source: NEA's Compilation of national fact sheets (last updated: 28 September 2004), see www.nea.fr/html/rwm/wpdd/welcome.html

2.1.2 Procedures for Funds Collection and Schedule for Funding

After the costs have been estimated and the amount of the liabilities determined as presented above, two others relevant problem arise. Regarding decommissioning financing, it is important to determine how the amount of the liabilities will be raised, when should it be provided and at what speed. The question here is, through what channels the funds are raised and within which time period? The practices on both issues in OECD countries are diversified.

Regarding fund collection methods, some countries rely on **electricity rates** while others raise funds through a **levy on electricity revenue**. Electricity rates method implies that decommissioning costs are component of nuclear generated electricity costs. In contrast, a levy on electricity revenue means that the funds are raised by a charge on the electricity system on a kWh basis. This is the case in Italy where there is no more nuclear generated electricity¹⁵. According to the NEA 2003 report, decommissioning funds are mainly raised through electricity rates in OECD countries¹⁶. Spain and Italy rely on levy on electricity sales to collect the decommissioning funds. It is difficult to class Sweden's practice in one of the two collection method. Although the fee determined by the government is not a general taxation on nuclear power, it is not clear to what extent it is included in electricity rates and consequently in the cost of nuclear generated electricity. This issue is not clear as well in Switzerland where annual contributions are paid into the fund by NPP owners.

Electricity rates and levy on electricity revenue methods link the fund collection to the operator's turnover. This is why another characteristic of funds collection applied by some countries is important to notice. In fact, **guarantees** may be required to the operator to cover decommissioning expenses if a

14. See EDF 2003 Annual Report.

15. In Italy, there are no more operational NPP. However, Italy still collects some funds by a levy on electricity sales to provide additional resources linked to the change in the decommissioning strategy. See NEA/RWM(2003)14.

16. See [9], page 51.

plant is closed prematurely or if those expenses exceed the volume of funds accumulated¹⁷. In Canada, the CNSC may draw upon financial guarantee established by the operator if necessary. The Finnish practice combine guarantees and gradual build in the external State fund¹⁸. This rationale ensures that the liabilities not covered by the NPP contribution into the fund are covered by guarantees. In Sweden, NPP owners are required to furnish different guarantees to prevent any insufficiency of funds. In the USA, D&D funds can be collected progressively through electricity rates or be covered by means of prepayment account or financial assurance mechanisms. To a large extent, guarantee is also applied in Switzerland. In this latter country, the NPP owners are obliged by law to act as guarantors.

The second relevant problem is the schedule for funding. That is, should the funds be set aside on a yearly 'pay as you go basis' or before the plant be commissioned? These methods refer respectively to **gradual build approach** and **prepayment**.

The current practices in OECD countries fall into these two categories. The **gradual build approach** consists of an annual payment (provision) reported in the balance sheet of the company during the commercial lifetime of the nuclear plant. It could also take the form of an annual contribution in an external fund. The **prepayment** approach requires the operators to provide the decommissioning financing before the plant begins its operation. The current practices in OECD countries regarding funds collection and schedule for funding is given in the table below.

Table 2: **Funds collection and Schedule for funding in some OECD member countries**

Countries	Funds Collection Methods			Schedule for Funding	
	Electricity rates	Levy	Guarantees	Gradual build	Prepayment
Belgium	X			X	
Canada	X		X	X	
Finland	X		X	X	
France	X			X	
Germany	X			X	
Italy		X		-	-
Japan	X			X	
South Korea	X			X	
The Netherlands	X			X	
Spain		X		X	
Sweden	-	-	X	X	
Switzerland	-	-		X	
UK	X			X	
USA	X		X	X	X

Source: NEA's Compilation of national fact sheets (last updated: 28 September 2004), see www.nea.fr/html/rwm/wpdd/welcome.html

2.1.3 Organisation of the Funds Management

The management of the funds collected is necessary because decommissioning implies costs that are very distant in time compared to the collection of the financial resources. One important issue here is the appointment of the manager of the funds¹⁹. Of course, this raises the question of ownership

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17. A deficit of funds could appear because the financing mechanism itself may prove less accurate or in case of a change in the regulatory regime of decommissioning.
 18. Nuclear Waste Management Fund
 19. There might simply be no funds to manage if the decommissioning is the responsibility of the State.

and control of those funds. There are two possible strategies regarding the organisation of the funds management. The management may be outsourced or not. This refers respectively to a management by an external body and to a management by the NPP owner (internal solution).

When the internal solution prevails, the management of the funds may or may not be unbundled from the electricity business of the NPP operator. In the latter case (management not unbundled), it can be envisaged that a statutory account carry a fraction of the funds.

In the case of an **external management**, two relevant organisational issues appear. The first is whether the external management should be centralized or not? The second is whether the external manager should be a private or a public body? From current practices in OECD countries, it can be observed that public property regime always goes with a centralised rationale of the management of funds. In this case, the existing fund is unique for the entire industry²⁰ without being a mutual fund. In Sweden for example, the central fund is properly speaking four different funds, one for each NPP operator. A mutual fund can be expected when the responsibility of decommissioning rest on a unique body as it is the case in Spain. Conversely, private property regime always goes with a decentralised management rationale. This implies that there could be as many funds as there are operators. The table below shows that current practices in OECD countries fall into two generic categories, namely outsourcing or internal management²¹.

Table 3: **Organization of decommissioning funds management in some OECD member countries**

Countries	Outsourced Management		Internal Management	
	Private body	Public body	Segregated	Non-segregated
Belgium	X			
Canada				X
Finland		X		
France				X
Germany				X
Italy		X		
Japan				X
South Korea				X
The Netherlands				X
Spain		X		
Sweden		X		
Switzerland		X		
UK		X	X	
USA	X		X	

Source: NEA's Compilation of national fact sheets (last updated: 28 September 2004), see www.nea.fr/html/rwm/wpdd/welcome.html

20. This is the case in Finland, Sweden, Switzerland, Spain. Belgium and the UK will also range in this case when Synatom for Belgium and the NDA for the UK will be operational. It is worth noting that the NDA will be the unique fund only for the state own NPP.
21. These categories are generic because several possibilities regarding ownership/control of the funds do exist. The owner under the supervision of the State can manage the fund, or it can be managed by a private company/bank again under possible control of the State, or it can be managed by the State under the control of a different State agency. The fund could be a mutual one or there could be a fund for each NPP owner or for each NPP.

Outsourced management may rest on a public and centralised body or on private decentralised bodies. In Belgium, a legal provision of June 2003 has outsourced the management of the funds in the benefit of SYNATOM SA, but the *decret royal* necessary for this provision to come into force is yet to be taken. SYNATOM SA is a subsidiary of NPP owners (Electrabel & Tractebel) in which the Belgium State retain a golden share. The Finnish Nuclear Waste Management Fund is a State fund in charge of the management of D&D funds of all the NPP owners. In Sweden, the fund is managed by an independent government authority (the Board of the Nuclear Waste Fund). This responsibility is also carried in Switzerland by a public body the *fonds de désaffectation des installations nucléaires*. In Spain, the public company ENRESA manages the funds since 1984. Since year 2000, Italy has empowered SOGIN, a public company, in this respect. In the UK, the system has evolved from an internal non-segregated rationale to an outsourced and state management rationale for public operator of NPP (BNFL & UKAEA). In fact, a new public body, the LMA (Liability Management Authority), was created in July 2002 and transformed in NDA (National Decommissioning Authority) since March 2003²². In the USA, the NRC introduced in 1998 an amendment in its trust fund requirements which provides that D&D funds may be managed through external sinking funds.

In the case of internal management, the NPP operators hold the funds. In its pure form, internal management do not rely neither on a statutory account nor on a trust. So other practices in this category are internal management combined with a statutory account (EDF, BNFL) and internal segregated management via a trust fund (British Energy).

2.1.4 *Procedures of Monitoring*

Several monitoring dimensions of funding mechanisms do exist. Costs estimates are submitted to periodical control as well as the inflow of resources into the fund. Another dimension is the monitoring of the management strategy of those resources and this is what the present section will deal with. In fact, once the manager of the funds is appointed, a concern still remains regarding the management of the funds. The concern is that of confidence in its management. The question here is how to organise the monitoring activity so that the management be effective regarding established principles (transparency, availability,). In this respect, OECD countries rely both on relevant sectorial authorities and on specific body.

Monitoring by relevant sectorial authorities (government departments in charge of the energy sector) is provided by all the national institutional frameworks. This aspect of monitoring consist in issuing more general rules. Some examples are, the *Direction Générale de l'Énergie et des Matières Premières* in France, the Department of Trade and Industry in UK, the *Office Fédérale de l'Énergie* in Switzerland, the BMU in Germany, the Nuclear Regulatory Commission (NRC) in the USA, etc.

Although monitoring by specific body can be found in all OECD countries, significant differences do exist at their operational level. In fact, some OECD countries have empowered **special purpose organisation** to carry out monitoring activities. This is the case in Sweden with the Nuclear Power Inspectorate (SKI). The Spanish institutional framework also provides that the *Comision Nacional de Energia* oversees the management of the funds. In Switzerland, the DETEC (Federal Department of Environment, Transport, Energy and Communication) has set up an Administrative Commission for this purpose. In Belgium, the above mentioned June 2003 legal provision also entitled the creation of a "Surveillance Committee". In contrast, other countries rely on **general purpose organisation**. That is to say the supervisor is not sector specific. This scheme is observed in France and Belgium with *La Cour des Comptes*. It is the case as well in the UK and in the USA where

22. The NDA is expected to be operational by April 2005. [See NEA/RWM(2003)14].

respectively the *National Audit Office* and the *Government Accounting Office* have the responsibility to assess the management of the funds. The remaining countries also fall in this category. In fact, Canadian monitoring process provides that the CSNC requires information from NPP owner on their decommissioning plans and financial guarantee but do not specify their contents. In the Finnish system, the Ministry of Trade and Industry is the supervisor of the funding mechanism. But this is a more general governmental body as it is the case of the Italian Ministry of Economy whose monitoring activity consists of issuing guidelines according to which SOGIN manages the funds²³. The Japanese system provides that regulatory authorities assess adequacy of the funds by reviewing accounting report submitted by the NPP owners.

Current monitoring practices in OECD countries are given by the table below.

Table 4: **Monitoring of the decommissioning funds management in some OECD member countries**

Countries	Relevant sectorial authorities	Specific body	
		Specialised	Non-specialised
Belgium	X	X	
Canada	X		X
Finland	X		X
France	X		X
Germany	X		X
Italy	X		X
Japan	X		X
South Korea	X		X
The Netherlands	X		X
Spain	X	X	
Sweden	X	X	
Switzerland	X	X	
UK	X		X
USA	X		X

Source: NEA's Compilation of national fact sheets (last updated: 28 September 2004), see www.nea.fr/html/rwm/wpdd/welcome.html

It is worth noting that a natural target when organising monitoring is the provision of access to relevant information. This is the case when the monitoring activities are carried out *ex ante* (definition of some limits to the behaviour of the manager of the funds at the beginning of the control period) and *ex post* (assessment of the behaviour of the manager at the end of the control period). From this point, another feature of monitoring important to notice is that this activity is carried out *ex ante* and *ex post* when the specific body is specialised. Conversely, monitoring is handled *ex post* only when the supervisor body is not specialised. Therefore, the supervisor is not submitted to the same information constraints as it will be emphasized later.

2.2 Current Funding Mechanisms

Funding arrangements applied in OECD countries represent a range of different approaches between the two extremes of an external mechanism as applied e.g. in Sweden and a internal mechanism as applied e.g. in France. Current mechanisms fall into three basic categories: internal non segregated mechanisms, internal segregated mechanisms, and external mechanisms. These mechanisms can be distinguished regarding some relevant functions from an organisational point of

23. By the way, we have not notice implementation of both *ex ante* an *ex post*, control in the Finish and Italian system.

view. These are, 1° the collection of funds, 2° the responsibility of the management of the funds and, 3° the organisation of the monitoring activity.

2.2.1 *Internal Non-segregated Mechanism*

In this model, operators are individually **responsible for collection** of financial resources. They are also **responsible for the management** of those resources. The funds are shown among the provision for liabilities in the company's balance sheet. It could be shown as well in a statutory account. Operators own/control the funds and are also responsible for financing the ongoing decommissioning operations if any. On the **monitoring** side, this model is characterised by non-specialised supervisor and thus by *ex post* monitoring activity. This model is actually the dominant one. A recent study carried by the NEA shows that in nearly 50% of the countries, the operators hold the funds²⁴.

2.2.2 *Internal Segregated Mechanism*

Regarding the **collection of funds** and the organisation of **monitoring**, internal segregated solutions have the same features as internal non-segregated mechanisms. In contrast, the **management of the funds** in internal segregated mechanisms rest on a different rationale. In this mechanism, the NPP owner also own a trust into which it contributes money for the purpose of decommissioning funding. The funds are managed by a separate body and this is supposed to be done without the NPP interference. However, there is no guarantee of the absence of conflict of interest despite the unbundling rationale. Therefore, this mechanism can be seen as an internal non-segregated mechanism with a generalised statutory account. This solution is applied in the UK for British Energy.

2.2.3 *External Mechanism*

In this model, the **responsibility of collection** may be assigned to operators or to an independent body, as it is the case in Spain with the *Comision Nacional de Energia*. The main characteristic of this model is the delegation of the **responsibility of the funds management** to a private or public independent entity (a fund). Indeed, this *ad hoc* entity controls the funds and is responsible for financing the ongoing decommissioning operations. Generally, public independent entities are unique and centralised (Finland, Sweden, Switzerland) whereas private independent entities are not. In the USA for example, external sinking funds are required for those NPP owner who collect D&D funds through electricity rates.

On the **monitoring** side, external mechanisms are characterised by the existence of a specialised supervisor. Therefore, the supervisor influences *ex ante* the investment choices of the manager of the funds and evaluates those choices *ex post*.

It is important to mention the role of the national legal framework on the selection of a type of mechanism. While some countries do subject the type of funding mechanisms to legal requirement, other does not. In that case, the legal framework only emphasizes the fact that appropriate measures should be taken to ensure the constitution and the availability of decommissioning funds. Current funding mechanisms in OECD countries are given in the table below.

24. See [9].

Table 5: The variety Funding Mechanisms in some OECD member countries

Countries	Is the type of mechanism subject to legal obligation?	Funding Mechanisms		
		Internal Non-segregated	Internal Segregated	External
Belgium	Since June 03	Before June 03		Since June 03
Canada	No	With guarantee		
Finland	Yes			Public body
France	No	With a statutory account		
Germany	No	No statutory account		
Italy	Yes			Public body since Yr 2000
Japan	No	No statutory account		
South Korea	No	No statutory account		
The Netherlands	No	No statutory account		
Spain	Yes			Public body since Yr 1984
Sweden	Yes			Public body
Switzerland	Yes			Since Yr 1984
UK	Yes (for the NDA)	With a statutory account Prior July 2002 for BNFL	Since 1996 for British Energy	Since July 2002 for BNFL & UKAEA
USA	Yes		Trust funds	External Sinking funds

Source: NEA's Compilation of national fact sheets (last updated: 28 September 2004), see www.nea.fr/html/rwm/wpdd/welcome.html

2.3 The combination of D&D funds control and of liabilities responsibility

The above mentioned differences in the design of funding mechanisms should not obscure the fact that those mechanisms are set up with a common objective which is to serve as a secure source of funds for the D&D operations. In fact, two responsibilities are involved in the decommissioning process. The first is to raise and/or manage the funds. The second is to own the liabilities or to be entitled to do so by the legal framework. Therefore, another point where the variety of practices can be stressed is the way according which these responsibilities are brought together in national framework. The issue here is how to organise the responsibility of D&D operations and that of funds management? Should they be borne by the same actor or should they be handled separately and in this case, how the relationship between both responsibilities should be defined?

According to the NEA 1996 report, there is no single way to couple the responsibility of D&D operation and that of management of the D&D funds. The various scheme stressed by that report fall in three categories. The first two are the extreme categories and the third one is in between:

1. The *first* category consists in putting both responsibilities in the hand of a central public body which is also external *vis-à-vis* NPP operators. This is the case in Spain where ENRESA manages the funds and bear the responsibility of proper realisation of D&D operations. It is the case as well in Italy with SOGIN and in the UK where the NDA will carry both responsibilities for the publicly owned NPP;
2. The *second* category consists in putting both responsibilities in separate and decentralised hands. In fact, the NPP operators are responsible of both the management of the funds and the realisation of D&D operations. This scheme is the most applied.
3. The *third* category is between the two previous. In fact, some countries have developed specific relationship since the responsibility of funds' management/control is put in the hands of a central public body also external *vis-à-vis* NPP operators while the D&D operations responsibility remain to NPP operators. This scheme is found in Finland, in Sweden and in Switzerland. Belgium has introduced this type of arrangement since June 2003. But it differs from the Swedish or Finnish solution by the fact that SYNATOM which will be the central and external manager of the funds is also a subsidiary of the NPP operators.

Table 6 presents a sum-up of the choice made by OECD countries.

Table 6: **The combination of D&D fund' control and of liabilities responsibility in some OECD member countries**

		D&D Liabilities responsibility	
		Centralized	Decentralized
D&D Fund's Management/Control	Centralized	<ul style="list-style-type: none"> • Spain • Italy • UK (for BNFL & UKAEA) 	<ul style="list-style-type: none"> • Belgium (since June 03) • Finland • Sweden • Switzerland
	Decentralized	-	<ul style="list-style-type: none"> • Belgium (before June 03) • Canada • France • Germany • Japan • South Korea • The Netherlands • UK (for British Energy) • USA

Source: suggested by NEA (1996)

3. COMPARISON OF CURRENT FUNDING MECHANISMS

The variety of funding mechanisms raised another concern which is about their respective capacity to offer an effective management of the funds. One way to cope with this concern is to examine their respective strengths and weaknesses. We need for that to rely on generally agreed principle. We also need to define some relevant evaluative criteria.

Throughout the civilian nuclear industry, it is admitted that an effective management of decommissioning funds should ensure their availability when needed²⁵. But what does this mean actually? Availability of funds can be seen as an objective of protection of funds. Then, the subsequent question is protection against what? As mentioned above, the duty of the manager of the decommissioning funds is to invest those funds. This is a risky activity. Therefore, the availability principle is a matter of avoiding financial insecurity. That is to say a high degree of confidence exists that the necessary funds will be available when needed regardless of changing economic conditions. For this objective to be achieved, the value of the funds needs to be less sensitive to worse economic conditions. From this point, we need to define some relevant criteria that will be considered in our assessment of funding mechanisms.

3.1 Evaluative Criteria

How are decommissioning funds exposed to financial insecurity? The answer of this question allows us to identify some evaluative criteria of the sensitivity of the value of the funds to changing economic conditions. Given the electricity deregulated context, these criteria are the exposure of the funds to electricity price volatility and to stocks price volatility.

- The new electricity context is characterised by deregulation²⁶ and **electricity price volatility**. In this context, electricity prices are set by market conditions rather than through rate base. Because market conditions always change, so it is for the electricity price. In fact, volatility may range from the price of the more efficient base load power plant to that of the less efficient peak load power plant²⁷. Because price volatility affects cash-flow and thereby the reputation of the company with investors, it can be a driver of financial insecurity of decommissioning funds²⁸.
- The new electricity context is also characterised by privatization and market valuation of the economic performance of electricity market players. This is to say stock market evaluates and

25. See [9] & [11].

26. Three main organization changes associated with deregulation are 1° consumer freedom of choice, 2° new business models and, 3° new market design (see [4] & [5]). Regarding markets, they can be bilateral Over The Counter market (OTC), spot market or balancing market. Neither the different markets have necessarily the same set of rules, nor they imply the same customer portfolio and the same power plant flexibility.

27. Regarding the UK experience, base load prices failed by 20% and peak load prices by 27% from 1999 to 2002. In California, price increase by more than 90% from 1998 to year 2000. See www.ofgem.gov.uk for UK and www.energy.ca.gov for California. According to the 2002 annual report of Powernext, the French power exchange market, volatility on baseload prices has been running at nearly 900% on a daily basis since November 2001 when Powernext started operation. Approximately, volatility was 700% on Germany's EEX and 1800% on the Netherlands APX.

28. The exposure of the company to price volatility depends on its business models. Several business strategies have emerged in the deregulation era. These are Merchant generator model, Power marketer/trader model, Retail business model. Business model determines among other things, 1° the consumer portfolio, 2° the type of assets, 3° the regulatory regime of the electricity business.

sanctions those performances. In a context of price volatility as mentioned above, one should expect uncertainty in NPP operator revenue, and consequently a high sensitivity of electric assets valuation to electricity price. Though the impact on assets valuation is a short-term one, it could persist across time because of the correlation between successive economic performance²⁹. Therefore, **stock price volatility** (for electricity production utilities) could be beyond the stock market indexes with generally ranges from 10% to 20%³⁰. The stock market volatility is a driver of financial insecurity, especially in a context of volatility of electricity market price.

To conclude, the new electricity context implies that the robustness of the funding mechanisms offered by the monopoly and vertical integration model cannot be longer observed. Because funding mechanisms could be impacted in the deregulation context, it is of interest to compare the robustness of existing funding mechanisms according to the above-mentioned drivers of financial insecurity.

3.2 Respective Merits of Current Funding Mechanisms

The harmful effect the deregulated electricity context may exert on the value of decommissioning funds depends on the features of the design of funding mechanisms. Because no institution will last forever, a complete protection of funds is not possible to attain. However, a better protection can be achieved if funding mechanisms are prepared to face the drivers of financial insecurity mentioned above. For these reasons, we will consider two relevant properties of funding mechanisms in this respect. These are 1° the visibility of the funds and, 2° the monitoring activity. Both are a matter of information as will be emphasized below. Let us evaluate the respective merits of different funding mechanisms according to those properties and to protection against financial insecurity.

3.2.1 *Evaluating the visibility of decommissioning funds*

The visibility of decommissioning funds is closely related to the way in which those funds are treated from an accounting point of view. The question here is whether or not a clear-cut separation exist between the funds and the other company's assets. Visibility implies that the funds be identifiable.

It appears that this condition is not observed by **internal non-segregated mechanisms**. This is because in this mechanism, the decommissioning funds have a status of cash-flow. Regarding accounting standards, the information given in the balance sheet (assets and liabilities) are not reliable from the funds visibility point of view. It appears that the funds cannot be identified unless the company's permanent assets are split up for information purposes. For these reasons, the visibility of funds is less clear despite the existence of a statutory account in some cases.

Because of its unbundled rationale, the **internal segregated mechanisms** offers a better visibility of funds. This is the case as well for **external mechanisms** within which the management of the funds rests on a legal separation principle.

3.2.2 *Evaluating effectiveness of monitoring activity*

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29. The situation of British Energy offers a good illustration of the persistence of past economic performance shocks on actual stock price. Despite the amelioration of the performance of British Energy, its stock price have not experience a similar amelioration testifying that the issue is much more complex.
 30. In UK for example, electric assets value decreased by 50% in 2002 in comparison of their value of 1999 due to wholesale prices decline (see [15]).

The effectiveness of the monitoring activity supposes an oversight of risks taken in the management of the funds. In fact, several investments strategies with different level of risk do exist. The funds could be invested in very low risk investment as government bonds for example that typically pay a real rate of return of only 2-3%. This strategy reduces the risk that the value of the fund will be lost³¹. The funds could also be invested in more lucrative investments (for example, equities or investments in stocks). In that case, the corresponding risk is higher and there could be a shortfall if the investment returns are over-estimated. The crucial question regarding D&D funds management is whether or not the supervisor influences the investment strategy. This perspective depends on the information constraints he faces. One way to assess those constraints is to look at the organisation of monitoring activity. In fact, organization may or may not allows the supervisor to define investment strategy of D&D funds.

We can expect a higher level of information constraints when the supervisor is not specialised. A non specialised supervisor provide periodical review and statement of D&D funds management. This is to say the supervisor only observed the results of the actions taken by the manager of the funds. Therefore, we can consider that the behaviour of the manager of the funds is hidden and that the supervisor faces a *moral hazard* situation³². Conversely, we will expect a low level of information constraints when the supervisor is specialised. In fact, a specialised supervisor influences the management strategy of the funds. He defines the strategy *ex ante* and assesses the corresponding outcome *ex post*.

Differences in the oversight of D&D funds management suggest that we can expect monitoring activity to be more effective when the supervisor is specialised compare to a non specialised situation. Therefore, **external mechanisms** may offer a more effective monitoring activity compared to **internal non-segregated mechanisms** and to **internal segregated mechanisms**. In the latter mechanisms, the supervisor faced substantial information constraints.

3.2.3 *Evaluating exposure to financial insecurity*

Financial insecurity is a matter of sensitivity of the value of the funds to electricity market price and stock price risks. As stressed above, the question here is whether or not prices volatility have an impact on the value of the funds. In fact, taking risk is valuable only if appropriate measures to cope with risk exist.

In an **internal non-segregated mechanism**, the owner of the NPP is also the manager of the funds. This solution may have the advantage of creating incentives for certain kinds of behaviour over time. In fact, the NPP owner mainly transforms decommissioning funds in long-term permanent assets. This is to say the provisions are rebuilt up in the operation of these companies. Only a small part of funds is carried by a statutory account dedicated to decommissioning if any³³. Therefore, this mechanism rest on the assumption that operational revenue will continue to generate financial resources to finance the liabilities when needed. Because the investment strategy is mainly to put the money in electric assets, this mechanism is not flawless since the value of the decommissioning funds

31. See [13].

32. *Moral hazard* is often called the agency problem and then identify with the Principal-Agent model by economists. A *moral hazard* situation arise when the principal (let say the supervisor in our example) only observes the outcome of the action taken by the agent (the manager of D&D funds in our example). Obviously, the outcome is an imperfect signal of the action taken.

33. See for example the EDF's account *Titres Immobilisés de l'Activité de Portefeuille.*, or BNFL's account Nuclear Liabilities Investment Portfolio.

is linked to the economic performance of the NPP owner: D&D funds are exposed to electricity market price volatility and thereby to stock price volatility. But the business model can diminish the exposure to these risks if appropriate.

Internal segregated mechanisms can be seen as offering a better protection against financial insecurity. In this mechanism, the money is set aside in a trust fund own by the NPP owner. The funds are dedicated so that they cannot be used for a purpose other than decommissioning. This argument is appropriate in normal circumstances only. In the case of financial distress of the NPP owner, a conflict of interest may occur because the NPP owner also owns the trust fund. Thereby, a worse financial situation may expose the decommissioning funds to financial insecurity.

In **external mechanisms**, the funds are managed via a legally separate body. This principle ensures a good visibility to the funds. It also implies that the funds remain outside the control of the NPP owner. Furthermore, the investment strategy is validated *ex ante* and evaluated *ex post* by a specialised supervisor. Because investment strategy is very restrictive as e.g. in Spain³⁴, the value of decommissioning funds is protected from financial insecurity which origin is electricity price volatility.

The table below summarises the respective merits of funding mechanisms. For each funding mechanism, we consider the elements of design which could prepared to face worsen economic condition of if well-tailored. These are, 1° the visibility of funds, 2° the monitoring activity features and, 3° the constraint upon the manager behaviour. Given the observed design, we consider the potential sensitivity of the value of the funds to changing economic conditions, then we conclude on the degree of protection of the funds offered by each mechanism.

Table 7: **Respective capacity of Funding Mechanisms to provide availability in a risky context**

Criteria		Funding Mechanisms		
		Internal Non-segregated	Internal Segregated	External
The design of the mechanism	Visibility of funds	Restricted to the statutory account if any	Guarantee by the unbundling rationale	Guarantee by the legal separation
	Supervision features	<i>Ex post</i> (the supervisor is under-informed)		<i>Ex ante & Ex post</i> The supervisor is well informed
	Behaviour of the manager	Unconstrained investment behaviour		Constrained investment behaviour
Protection from financial insecurity	Sensitivity of D&D funds to electricity market price	High	No (in case of good performance of the NPP owner)	No
	Sensitivity of the D&D funds to stock market valuation	High	Possible	No
Conclusion on the degree of financial insecurity in a deregulated electricity context		High	No general response. Financial situation of the NPP owner matters	Very low

34. In this country, the investment of the funds is limited to Spanish State bonds Spanish, to credible foreign State bonds and to the equity of some large companies.

4. CONCLUSION

This paper has reviewed the current D&D funding mechanisms in OECD countries. The paper has shown that those mechanisms are varied regarding their design. It has also appeared that the responsibility of management/control of the funds in the one hand and the legal responsibility of decommissioning are articulated differently.

Given the variety of design, the paper has assessed the respective strength and weakness of the current funding mechanisms in a deregulated context. In fact, the duty of the manager of the funds is to invest those funds and to ensure their availability when needed. Because there is no investment without risk, the paper has stressed the financial insecurity to which the funds may be exposed in a deregulated context. Some main conclusions of this assessment are the following:

A better protection of funds in a deregulated context supposes a ring fence between the value of the funds and the deterioration of the economic and financial situation of the nuclear power operator. This objective is subjected to information constraints. Given financial insecurity drivers in a deregulated electricity context, at least two properties of the design of funding mechanisms are necessary to overcome the information problem and to achieve an effective protection of funds.

First of all, the funds need to be visible or identifiable. In this respect, fund management effectiveness regarding availability purpose is linked to the status of the manager. In fact, visibility is higher when the responsibility of management is separate from the responsibility of operation of the nuclear power company. In fact, the accounting treatment of the provisions for liabilities has significant consequences on the visibility of funds. This can threaten the availability of funds in a deregulated context.

Secondly, the monitoring of the funds' management needs to be appropriate regarding transparency and protection against financial insecurity brought by the deregulated electric context. The best way to do this is to explicitly delineates what the decommissioning funds can be used for and finally how the funds are to be managed. Given information constraints, it appears that the protection of the funds is better ensured when the monitoring activity rests on specific and well-tailored organisation. Generally, such organisation are observed when outsourced management solution prevails.

Finally, the paper suggests that internal non-segregated mechanisms does not provide a high degree of financial security as putting the management of the funds needed to cover decommissioning expenses in the hands of a separate body.

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Session 3 – UNCERTAINTIES IN FUNDING

FINANCIAL RISKS IN MAJOR INVESTMENT PROJECTS

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We have probably all read about large projects which proved far more expensive than anticipated, projects such as the Channel tunnel which cost 80% more than planned, and the oil pipeline between the oilfield in Prudhoe Bay in Northern Alaska and the oil terminal in Vadez in the south which overran its budget by 1,000%.

The purpose of this paper is to summarise our knowledge of the risk of cost escalation. Which projects are more likely than others to be hit by cost escalation, and why?

Table 1 shows the average cost overrun for a few studies of large construction projects. Figures within brackets are in constant money value. Cost overrun is the norm. A review of 35 studies of groups of large projects by Morris and Hough (1986) did not identify a single instance in which the groups of projects concerned on average had become less expensive than anticipated. This allows us to assert that:

P1 Cost overrun between decision and follow up is more common than cost underrun.

Table 1. **Cost overrun according to five studies of groups of large construction projects**

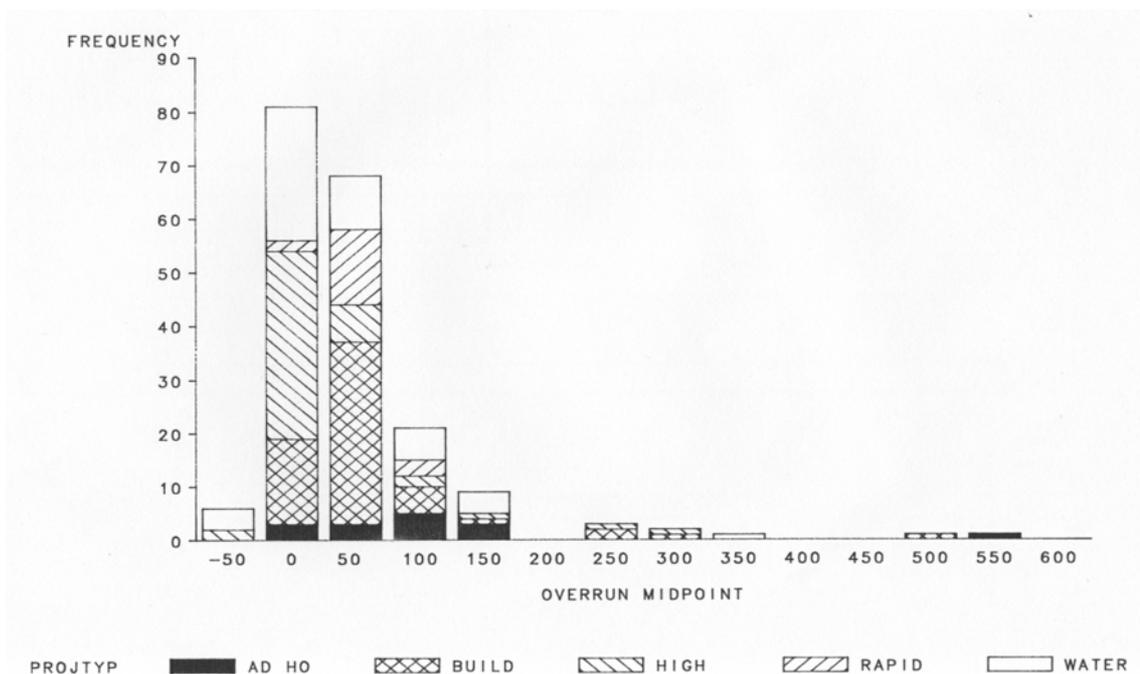
Study	Type of project	Number of projects	Average cost overrun
Hufschmidt & Gerin (1970)	Bureau of Reclamation		
	Projects -1955	103	+177%
	Projects 1935-1960	128	+72%
	Projects 1946-1960	54	+9,4%
	Corps of Engineers		
	Projects -1951	182	+124,1%
	Projects 1933-1965	184	36,1%
	Projects 1954-1960	68	-0,2%
	Tennessee Valley Authority	34	-5,3%
Merewitz (1973a, b)	Water resource projects	49	+38%
	Highway projects	49	+26%
	Building projects	59	+63%
	Rapid transit projects	17	+54%
	Ad hoc project	15	+114%
	All projects	189	+59%
NED (1980)	British offshore projects	-	+179% (+146%)

	Norwegian offshore projects	-	+178% (+148%)
GAO (1983)	US public military projects	244	+127%
	US public civilian projects	200	+92%
Flyvbjerg <i>et al.</i> (2002)	Railway projects	58	(+44,7%)
	Bridges and tunnels	33	(+33,8%)
	Road projects	167	(+20,4%)
	All projects	258	(+27,6%)

Figure 2 shows the distribution of cost overruns for the 193 major U.S. infrastructure projects which Merewitz (1973b) have listed in his article. The graph forms a typical distribution with a positive skewness. Most projects come out close to zero or with a small cost overrun while a few show very large overruns. Those most seriously affected are what Merewitz termed ad hoc projects, i.e. unusual, seldom implemented projects such as research and sport facilities, unique public buildings and establishments, projects for which no prototype existed.

P2 Cost overrun tends to be larger for unique, seldom implemented projects.

Figure 2. The size and frequency of cost overrun in 193 major U.S. infrastructure projects



It is not uncommon to claim that large projects are often affected by cost overrun, although studies of groups of similar projects show that the opposite is often the case (Hufschmidt & Gerin, 1970; Mansfield *et al.*, 1971, 1972; Segelod, 1986; Odeck, 2004; Flyvbjerg, 2004). Calculated as a percentage small projects vary more than large ones.

P3 Calculated as a percentage the deviation in cost between decision and follow-up varies more for small than for large projects.

Summers (1967), Hufschmidt & Gerin (1970), Merewitz (1973a, b), Segelod (1986) and Federle & Pigneri (1993) all found a connection between cost overrun and the duration of the implementation of the project. The longer it takes to implement a project the greater the modifications of the original plan tend to be, viz. the adaptation of the project to changing market demand, new standards and new technology. However, the incurred cost cannot be completely recovered so that the final cost is increased by the number of modifications which prove necessary (Giguet & Morlat, 1952), and to make changes becomes progressively more expensive as the project approaches completion. Perhaps this is why the frequency of cost overrun, as in Figure 1, often shows a positive skewness.

P4 The longer the interval between estimate and follow-up the larger the cost overrun tends to become.

This also means that projects which experience cost overrun often also show deviations on the market, product side and the technical solutions chosen.

P5 There is often a covariance between cost and time overrun, as well as other types of deviations between plan and outcome.

R&D projects have shown a tendency to escalate. Therefore, U.S. economists already in the 1950's started to study the reasons for cost escalation in military aircraft and missile projects. They soon discovered that cost overrun correlated with advances in technological development (Marshall & Meckling, 1962; Summers, 1967), a result which was later confirmed to apply also to pharmaceutical products (Mansfield *et al.*, 1971, 1972) and R&D projects within the engineering industry (Svensson, 1990).

P6 The greater the advance in technical knowledge the larger the cost overrun.

The reasons for cost escalation are the same as for construction projects. To make an estimate the estimator must start from a design. He does so and adds on a lump sum for contingencies. But as technical advances are required unforeseen problems may arise, and the longer the development time the more the available technology and market demand change. This means that new drawings must be produced upon which new cost estimates can be based.

There is much research showing that humans tend to underestimate the time and cost of what they plan to do. We speak of an optimistic bias. Such over-optimism has been confirmed to exist in a number of areas, e.g. capital investment decisions (Stateman & Tyebjee, 1985), market forecasts (Mahajan, 1992), venture capitalists (Zacharakis & Shepherd, 2000), and entrepreneurs starting up new businesses (Hornday, 1982; Cooper *et al.*, 1986; Egge, 1987). Research also shows that we tend to have more confidence in our estimates than is reasonable (Bazerman, 1990). Furthermore, corporate managers are aware of, and adjust for, the optimistic bias in the investment requests they have to assess (Pruitt & Gitman, 1987). It is sometimes difficult to know whether estimators deliberately, or unconsciously, underestimate the time and costs to raise funds or promote their interest. Anecdotal evidence (Segelod, 1986; Pruitt & Gitman, 1987; Wachs, 1989, 1990; Flyvbjerg *et al.*, 2002) gives example of both deliberate and unconscious underestimates.

P7 Estimators, and especially entrepreneurs, tend to underestimate the real time, cost and resources needed to implement the projects they wish to complete.

When the budget is limited and two, alternative, projects are competing for funding, the one in which the cost is underestimated stands a better chance of being approved. Gaspar & Leite (1989/90) and Pickrell (1992), among others, argue in favour of this maxim postulated already by Giguet & Morlats (1952).

P8 Projects in which the cost is underestimated tend to stand a better chance of being funded, than competing projects.

Hufschmidt and Gerin (1970) found that the Tennessee Valley Authority made more accurate estimates than the Corps of Engineers and the Bureau of Reclamation. His explanation was that all cost estimates in TVA were produced by a small staff with long experience of costing, while investment appraisals were decentralized in the other two organizations. The fact that the accuracy of cost estimates varies considerably between different organizations was confirmed by Mansfield 1971 *et al.* (1971), Svensson (1990) and Federle & Pigneri (1993).

P9 Cost overrun is more common in some organizations than in others.

Considering how fast our knowledge about construction projects is growing, and how easy it has become to search for information it is reasonable to assume that cost overrun is less common today than in the past. Hufschmidt and Gerin (1970) and Summers (1967) found that cost estimates for new power plants, military aircraft and missiles had become more accurate, but Flyvbjerg *et al.* (2002) discovered no improvement among infrastructure projects in the last 100 years.

P10 Cost estimates produced today are not always more accurate than estimates of similar projects made in the past.

We began by referring to the Trans-Alaska oil pipeline which was estimated to cost \$863 million at the time the decision to invest was made but actually cost \$9,300 million. An enormous cost escalation but still of minor significance as the Alaskan oil venture was expected to yield a yearly profit of \$44-100 billion (Hauck & Geistauts, 1982). The fact that the project has encountered cost escalation does not necessarily mean that it will prove unprofitable in the long run.

We should also remember that many profitable investments in radical innovations (Freeman, 1974), new ventures (Segelod, 1995) and important infrastructure investments (Sayer, 1952) would never have been undertaken if their true cost had been known when the decision to invest was made. In this perspective an underestimation of the real problems and costs has often proven to be a precondition for industrial renewal and economic growth.

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Uncertainties affecting fund collection, management and final utilisation³⁵

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Abstract

The paper presents, on a general level, major uncertainties in financing systems aiming at providing secure funding for future costs for decommissioning. The perspective chosen is that of a fund collector/manager.

The paper also contains a description of how these uncertainties are dealt with in the Swedish financing system and particularly from the perspective of the Board of the Swedish Nuclear Waste Fund. It is concluded that existing uncertainties are a good reason not to postpone decommissioning activities to a distant future. This aspect is important also when countries have in place financing systems that have been constructed in order to be robust against identified uncertainties.

1. UNCERTAINTIES IN FUNDING FOR DECOMMISSIONING³⁶

1.1 Areas of uncertainties

In accordance with the ethical principle of intergenerational fairness, future costs for decommissioning of nuclear power plants (NPPs) should be borne by the generations that have benefited from the primary, producing activity. Such an approach leads to the conclusion to set aside, during the productive lifetime of NPPs, sufficient financial resources (funds) to cover costs in the future. These funds should be available, when the moment comes, to cover upcoming costs for decommission nuclear facilities, remediate sites, and manage the associated wastes. A liability for future generations would exist if such resources are not allocated – or the resources are found to be insufficient.

But is it possible to ensure that ‘sufficient’ resources are set aside? And who decides what is ‘sufficient’?³⁷

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- 35. S. Gordelier (United Kingdom Atomic Energy Authority), V. Massaut (SKC-CEN, Belgium), F. Tchapgá (PhD Economics, GRJM-ADIS-Université Paris 11, France) and E. Warnecke (Federal Office of Radiation Protection, Germany) have reviewed drafts of the paper and contributed valuable comments.
 - 36. The same uncertainties are in principle also applicable in funding for future disposal of high-level radioactive waste and spent fuel.
 - 37. Setting aside financial resources for future use can be done as internal funding in the accounts of the producer or as external funding. External funds can be managed by operators or by bodies independent from them.

One way of coping with this problem is to identify possible uncertainties in a systematic way and analyse what can be done to eliminate them – or at least reduce them as much as reasonably achievable. A similar approach as is used as a basis for the well-known ALARA-principle (established within the field of radiation protection) seems to be applicable also for handling uncertainties with regard to funding for future decommissioning!

For the purpose of this presentation, it seems helpful to distinguish between uncertainties within four areas. Thus, the uncertainties could regard:

- The accuracy of the cost calculations forming the very basis of any fund system
- The inflow of resources into a fund system.
- The management of resources within a fund system.
- The time factor – when will calculated costs occur?

The fact that these four categories of uncertainties at the same time are interdependent of each other complicates the picture even more.

1.2 Uncertainties regarding the accuracy of the cost calculations forming the very basis of any fund system

A good illustration of existing uncertainties of this kind can be found in the NEA report *Decommissioning Nuclear Power Plants – Policies, Strategies and Costs* (2003). In this report it was concluded that at least the following nine aspects had significant effects on decommissioning costs (p. 10 – 11):

- The end state of the facility after decommissioning (e.g. green field, long-term stewardship of some facilities, site reuse for other industrial or nuclear purposes);
- The national policy, and site-specific application, of site release criteria;
- The inclusion of waste disposal costs – totally, partially or not at all – in the decommissioning scope and cost estimates;
- The manner in which waste arising from decommissioning is classified, in terms of whether or not radiologically regulated disposal is required;
- The assumed costs for waste disposal, recognising that no country reported having operating disposal facilities for all types of waste that would be generated by decommissioning processes;
- The decommissioning strategy option assumed for costing purpose (e.g. longer or shorter safe-store periods and choice of decommissioning end point);
- The national labour costs that were assumed;
- Social and political factors, such as the decision to decommission very rapidly, or to release sites only to very stringent radiological criteria;
- Uncertainties in the estimates and their treatment in cost models.

In addition to these general aspects that affect costs, the study also identified several physical characteristics of the power plant considered that were also significant cost drivers:

- Type and size of the reactor.

- Number of units on the site.
- Operating history of the plant; and
- The amount of waste assumed to be generated.

The best way of handling uncertainties of this kind seems to be the constant development of cost estimations based on continuous learning from different decommissioning projects that have been successful or less successful with regard to projected and actual costs.

1.3 Uncertainties regarding the inflow of resources into a fund system

There are two possible principles to collect reserve funds for decommissioning. One is paying the projected costs in advance ('prepayment'). This means setting aside financial resources before a reactor is allowed to start. The second principle is building up the funds gradually. Since decommissioning costs are components of total costs for nuclear-generated electricity, the financial resources are in both cases finally borne by consumers through electricity rates.

If a model with *prepayment* is chosen, there is no uncertainty regarding the actual inflow of resources into the funding system. The use of this method would, however, require that decommissioning costs for the project could be reasonably well estimated before the facility has been built, or at least before nuclear activities in the facility have been permitted to start. This requirement is obviously difficult to meet (cf. section 1.2). So even if a system of prepayment were theoretically feasible, it would probably have to be supplemented by a mechanism allowing for later adjustment of the reserve.

A *gradual build up of reserves* can be constructed in different ways. Common practice is to set aside a certain amount per produced (or delivered) kWh of nuclear-generated electricity. This means that the building of the reserves is closely linked to the production of nuclear power and that consumers of nuclear power have to settle the final bill through the prices they pay. In some countries the build up of reserves is made by setting aside a certain amount per sold kWh of all electricity. This means that the collective of electricity consumers have to carry the costs for decommissioning of nuclear power production.

Any system for gradual build up of reserves has to be based on basic assumptions concerning the commercial lifetime of the NPP, or concerning a shorter 'earning-period' during which resources to cover all future costs should be collected. From an assumed time-period it is possible to assume the size of the production (expressed as the volume of produced or delivered kWh or TWh) from a certain reactor. And from this assumption it is possible to arrive at a certain amount per kWh that should be set aside. But how certain are the assumptions of a certain total production? Which resources will be accumulated in the case of a major interruption of the operation of a NPP?

One way of reducing this uncertainty is to provide for regular reviews of basic assumptions on total or annual production from the NPPs. Such reviews are important, as basic assumptions on future production form one of the bases for calculating the amount per kWh that should be set aside.

1.4 Uncertainties regarding the management of resources within a fund system

Management of collected funds is necessary because the physical activity of decommissioning results in costs that will occur much later than the resources are collected.

What is a reasonable target for managing such funds? In the first place, funds should be managed to ensure that the real value of collected resources is kept. In an economy with inflation – which is the case in almost every country – this means that management should ensure that the collected resources at least grow at a rate that corresponds to inflation (measured one way or another). A more ambitious – but still feasible – goal for fund management is to ensure that real value is added to these resources before they have to be used for their purpose. Resources set aside to cover future costs should be used for productive purposes in the economy (investments) before they have to be spent for the intended purpose.

Capital that is managed in order to provide a return is exposed to different financial risks. The exposure and risks in the investment activities are to be clearly measured and followed up by applying generally accepted financial market methods. The following is a brief description of these risks:

- *Inflation risk* is the risk that inflation exceeds the return on the collected capital, resulting in negative return in real value.
- *Market risks* are the risks that the value of the collected capital varies due to developments on the financial markets.
 - *Stock-market price risks* are the variations of market value of shares. Experience shows that the value of shares varies greatly from time to time.
 - *Interest risks* are the changes in the value of interest-bearing securities, which arise when the market rates rise, or fall. The impact is determined by the maturity. A longer maturity will result in a greater value change in connection with a given market rate change. Interest rate risks can therefore be reduced by limiting the maturity. The measure applied to interest rate risk is usually the duration. In order to limit the interest rate risk, a duration limit is usually established.
- *Credit risks* comprise issuer risks and counterparty risks.
 - *Issuer risk* is the risk that the party issuing a promissory note will not pay the interest and repay the principal on the due date.
 - *Counterparty risk* is the risk that a counterparty, in connection with a purchase or sale, will not be able to fulfil his obligations in connection with the settlement of the transaction. Counterparty risks can be limited by establishing firm rules for how transactions should be carried out.
- *Liquidity risk* is the risk that, due to the market situation, a security cannot be sold at the desired time, at the desired price and/or at the desired volume.
- *Currency risk* is the risk that certain costs are to be paid in foreign currencies and thus be influenced by possible unexpected variations in currency exchange rates.
- *Administrative risks* can arise due to deficient routines concerning how transactions are to be conducted, confirmed, controlled, registered, accounted for etc.

These types of financial risks are the same in all kinds of capital management, for instance in the case of managing pension funds. It is necessary to establish a balance between the expected return on capital investments and the risk the manager is willing to accept in order to obtain that return. Generally, a higher risk may result in a higher return. Based on such a balancing point, it is possible to establish which sort of assets the fund capital can be allowed to be invested in.

There remains, however, one uncertainty of major potential importance. This uncertainty is difficult to address. The reason is that this uncertainty is not particularly the business of a fund collector/manager but rather the business of all actors in a community that has established a funding system.

This uncertainty concerns the possibility that the *legal rules* forming the basis for a financing system are *changed in a way that undermines the whole idea*. A condition for a sound long-term funding system is no doubt a certain economic stability. Theoretically, a nation might get into such deep economic difficulties that existing legislation is changed to allow the use of collected funds for other purposes than originally intended.

Also the possibility of misuse of funds by criminal actions, or total loss of funds due to e.g. warfare, is a possibility.

1.5 Uncertainties regarding the time factor – when will calculated costs occur?

Apart from keeping – and preferably increasing – the value of a fund, a fund manager's second duty is to have the assets available when needed for their purpose, e.g. to cover future costs. This means that the management of a fund includes careful liquidity planning.

But a successful liquidity planning is dependent on reliable forecasts concerning when major costs will occur. For a capital manager it makes a big difference when considering different investment options if the invested asset should be available for costs that have to be paid within 5-10 years from now or from 30 years from now. Uncertainties regarding this time factor will inevitably result in less well-informed investment decisions.

Uncertainties regarding the time factor depend largely on the kind of decommissioning strategy or decommissioning policy³⁸ that has – or has not – been adopted in a country. A fund manager might not be able to influence decisions on decommissioning strategy or decommissioning policy – but should ensure a good knowledge of the implications of chosen strategies and policies within this field.

1.6 The interdependency between major uncertainties

So far, major uncertainties have been identified within four areas. At the same time there is interdependency between these uncertainties. The need for inflow of more resources is dependent of how resources that have already been collected are managed, of the availability of high quality cost estimations and of the uncertainties associated with the predictions when the resources are needed. Uncertainties regarding the time factor affect the investment decisions and thus the results of fund management.

Given the existence of uncertainties with regard to inflow of resources, to cost calculations and the time factor, it could be debated whether there are strong enough reasons to take any financial risks at all in the management of the assets.

38. The concepts of *decommissioning strategy* and *decommissioning policy* are used as explained in the earlier mentioned NEA-study 2003. Thus *decommissioning strategy* refers to industrial approaches to decommissioning, while *decommissioning policy* refers to government policy and includes all governmental choices as described in laws, regulations, etc. that will influence the framework in which decommissioning takes place.

It seems as if the strength of this argument is highly dependent on the credibility of cost calculations and of assumptions when calculated costs will occur. If cost calculations are based on many uncertain assumptions and therefore have a low degree of credibility, it might be a good strategy to manage the assets taking the lowest possible financial risks and expecting a very low return. It should however be noted that different actors – the operators or a Government – might have different views on the desired point of balance between risk and return in the managing of funds.

2. HANDLING OF DIFFERENT UNCERTAINTIES IN SWEDEN

2.1 Background: Brief facts about the Swedish financing system

Main components in the Swedish financing system can be summarized in eleven bullet points. An illustration of the system is attached as *enclosure 1*. For overviews of some key developments and facts, see *enclosures 2 – 7*.

- A fund is created by fees paid by the four producers of nuclear energy;
- The size of the fees are decided by the Government based on cost predictions by the producers (checked by a government authority, the Swedish Nuclear Power Inspectorate);
- The four production utilities pay different fees, calculated on different projected costs, and are considered to have different shares of the assets of the fund;
- The size of the fee is decided annually based on cost calculations that the operators have to present once a year;
- The fund is administered by an independent government authority (the Board of the Nuclear Waste fund). The owners of the nuclear power producers have a right to nominate a minority of the board members – but once appointed by Government these board members also have to work according to rules set up by the Government;
- The producers of nuclear energy have a legal right to be reimbursed from the fund for their expenses for future decommissioning (and for disposal of spent fuel);
- It is the responsibility of the Board both to ensure an adequate return on the investments and to ensure that money will be available when needed;
- Investment rules are given in the legislation and allow investments only in bonds and treasury bills issued by the Swedish state;
- It is the responsibility of the Nuclear Power Inspectorate to decide which expenses are entitled to be reimbursed to the nuclear operators from the fund;
- The producers are entitled to a repayment, should there be a surplus in the fund, when all legal obligations with regard to decommissioning and disposal of spent fuel have been fulfilled;
- To make the financing system more robust, it was decided in the middle of the 1990s that the producers have to provide two types of guarantees to the State:
 - *Guarantee I* is intended to cover a case where fees will not be paid to the Fund in the event of an early reactor shutdown (calculations are based on a 25-year ‘earning-period’);

- *Guarantee II* is being gradually built up and is intended to cover the lack of funds in the event that the Fund balance, after all the reactors are shut down, should be found to be inadequate to finance the expenses.

In principle this financing system has been in place since the early 1980s, even if important changes have been made over the years.

It should be stressed that the fee is not a general taxation on nuclear power. Instead, it is a fee to be paid to a Government authority as a basis for a government-administered separate financing system that should produce the necessary financial assets to cover future costs. It should produce the necessary financial means – but no intended surplus! It is in the interest of both the operators and of the consumers – and also of the Government – that the fee is ‘correct’. And a ‘correct’ calculation of the fee depends greatly on the accuracy of certain basic assumptions that have to be made.

The size of the fee is dependent on at least four major factors. All these factors contain uncertainties and they are also interdependent of each other. These factors are:

- Calculated future costs.
- Assumptions on when future costs will occur.
- Assumptions on future production of electricity from NPPs (amount of TWh and for how long reactors will produce).
- Assumptions on future return on capital already collected in the Nuclear Waste Fund.

2.2 Handling of uncertainties regarding the accuracy of the cost calculations in the Swedish funding system

The legislation regulating the Swedish financing system has always contained provisions aiming at securing a regular overview of cost calculations.

In principle, the operators should annually present their cost calculations on remaining costs for decommissioning (and for disposal of spent fuel). These cost calculations are presented to the Swedish Nuclear Inspectorate. As the cost calculations are used by the Inspectorate as one of the bases for its proposal to the Government on the size of the fee during the coming year, the Inspectorate should review the estimations in order to form its own opinion of whether estimates are realistic. Up to now, the Inspectorate has only found reasons to question these calculations in minor details.

As a result of considerations in the middle of the 1990s about how to make the Swedish financing system more robust, some new provisions were introduced in the legislation. According to these provisions, the reactor owner must provide adequate guarantees to cover the lack of funds in the event that the Fund balance, after all of the reactors have been shut down, should be found to be inadequate to finance the expenses in connection with disposal of spent fuel and the decommissioning of NPPs. These guarantees are called *Guarantee II*³⁹ and are intended to cover the possibility that certain measures prove to be more expensive than estimated, that certain measures must be adopted earlier than intended or if the return on the capital should be lower than assumed in the fee calculation.

39. About *Guarantee I*, see section 2.3.

The Government decides the size and type of securities, which are to be accepted. The amount of Guarantee II is being built up gradually. In 2003 the nominal value was 3.8 billion SEK, corresponding to almost 13% of the value of the assets in the Fund (cf. *enclosures 4 and 7*). The Board of the Nuclear Waste Fund has no responsibilities with regard to the making or reviewing of cost calculations for decommissioning or disposal of spent fuel, but is the authority keeping the securities.

Matters about how the Government and its authorities should review the operator's cost calculations and about the system of securities are currently being considered by a Government committee that will report its findings in late 2004.

2.3 Handling of uncertainties regarding the inflow of resources into the Swedish funding system

The system of annual decisions on the size of the fee is one way of handling this uncertainty. Based on more and more experience from the actual electricity production from the reactors, it has been possible to produce more exact forecasts of future production.

The state-controlled financing system introduced in 1981 was originally designed to collect the necessary financial means – by means of a certain fee per kWh nuclear electricity – during an assumed production time of 25 years for each reactor.

There was one basic uncertainty in this concept: what would happen if, for one reason or other, a reactor will have to be shut down earlier than after 25 years of operation? During the first 15 years of the financing system, there was no mechanism in the system to cover such an event. But in order to make the system more robust, measures to that end were taken in the middle of the 1990s. Since then, the operators must provide a certain type of security (called Guarantee I) to the Government. Through these guarantees, payments will be made to the Fund at the same rate as if the reactor had been in operation. Since this will be done, the funds will be accumulated as planned, regardless of whether one or more reactors are shut down before they have been in operation for the 25 years upon which the calculation is based. The size and type of security is decided by Government annually. In 2010 there will be no need for any operator to provide for this type of security.

There is currently enough money in the funds to cover the projected decommissioning costs for the six reactors which have been operating 25 years or more. In 2010 all reactors will have passed their 25 years of operating time and all the money needed for decommissioning will be collected – provided, of course, that cost calculations are correct.

2.4 Handling of uncertainties regarding the management of resources within the Swedish funding system

Investment rules for the Swedish Nuclear Waste Fund are decided through legislation by Parliament. When the system was set up in the early 1980s, the fees were simply collected in interest-bearing bank accounts with the Bank of Sweden. The level of interest on these funds should correspond to the average interest on ten-year nominal treasury bonds. The actual level was decided monthly by the Bank of Sweden.

This system was changed in the middle of the 1990s. A separate government authority, the Board of the Nuclear Waste Fund, was given the responsibility to manage the fund according to rules given in legislation. Current rules prescribe that the assets in the Fund are to be deposited in interest-

bearing accounts at the Swedish National Debt Office or in promissory notes issued by the state. In practise, the bulk of the assets is invested in nominal and real interest government bonds, with varying maturities.

The task of the Board is two-fold. One task is to assure that money will be available when needed. The second is to attain the highest possible real return on the administered capital – taking into account the limitation on the investment activities prescribed in the legislation. During the period of 1996 – 2003 the real return on investments was 6.2 % on average per year. This level should be compared with the target set up in 1996 for the whole period of 1996 – 2020, which was 4.0 % on average per year. The Board's current target for the period 2004 – 2020 is 3.25 % on average per year. This target is set taking into account existing investments in different government bonds. For the period after 2020 the uncertainties are higher. The Board's current expectation is that the average annual rate of return will be 2.5 % from 2020 onwards.

Based on these assumptions on future return on invested capital, and taking into account available information concerning estimated fee-based incomes and expenses in coming years, the Board presents annually to the Government a rough estimate of the expected development of the Fund assets up to the 2050s. The latest estimate of this kind was presented in February 2004 (*enclosure 8*). These estimates indicate no shortfall of the Fund. However, it should be stressed that the uncertainties behind the estimated development of the Fund are considerable.

In section 1.4 some examples of financial risks have been presented. The Board's current view on these risks and uncertainties can be summarized as follows⁴⁰:

- *Inflation risk*: To reduce the risks of the capital being eroded by inflation, a minimum of 60% must be invested in real rate bonds.
- *Market risks*: Since investments are allowed only in bonds and treasury bills issued by the Swedish state, the only market risks are considered to be the *interest risks* (for a definition of the term 'interest risk', see section 1.4). To reduce these risks, the duration of the investments of the Nuclear Waste Fund is limited (must not deviate from a comparison index by more than 5 years);
- *Credit risk*: Since investments are allowed only in bonds and treasury bills issued by the Swedish state, no limits are needed for the issuer *risk*. To meet *counterparty risks*, firm rules have been established. The rules are the same as applied by the Swedish Legal, Financial and Administrative Services Agency (the Government has decided that this agency should act as 'host agency' for the Board).
- *Liquidity risk*: Nominal rate government bonds and treasury bills normally have a good liquidity on the interest rate markets. However, the market for real interest rate bonds is normally not so liquid that substantial volumes can be sold at short notice. Since the administration of the Nuclear Waste Fund is long term, no specific limit is specified for the liquidity risk in real interest rate investments.
- *Currency risk*: As available information indicates that less than 10 % of the Fund's future expenses will have to be covered in foreign currencies, the currency risks are regarded as minimal. Up to now, no measures have been regarded necessary to meet such risks.

40. Note that assets in the Swedish Nuclear Waste Fund are meant to cover costs both for decommissioning of NPPs and for disposal of spent fuel.

- *Administrative risks:* These risks are managed by the Legal, Financial and Administrative Services Agency handling the administration and applying the same routines that the Agency otherwise applies in its asset management activities.

2.5 Handling of uncertainties regarding the time factor in the Swedish funding system

A basic uncertainty regarding the time factor is the future of nuclear power in Sweden.

As is well known, there has earlier been a policy decision in Sweden to phase out nuclear power by 2010 at the latest. This was official energy policy 1980 – 1997. Later energy policy decisions by our Parliament have confirmed a policy to phase out nuclear energy, but no end year is mentioned. One of the original 12 reactors, Barsebäck 1, was closed in November 1999 and has been permanently taken out of operation. Negotiations on important details of a phase-out policy have been going on between the Government and the electricity producers (the owners of the NPPs), but ended in early October 2004 without any agreement. The Government then announced its firm intention to close down Barsebäck 2 during 2005 and to continue a policy of phasing out nuclear power. The Government claims to have support for such a policy by a majority in Parliament, founded on an agreement between some of the political parties. However, different developments of these issues cannot be ruled out.

11 reactors (included Barsebäck 2) are currently operating, and the owners (both state-owned and private-owned companies) are making substantial investments in the reactors in order to allow both an increased and a prolonged production. The industry is planning for total operational times of at least 40 years per remaining reactor.

Obviously, there is currently an uncertainty in assumptions on future nuclear production. As mentioned in section 2.2, the state-controlled financing system introduced in 1981 was originally designed to collect the necessary financial means for securing decommission (and disposal of spent fuel) during an assumed production period of 25 years for each reactor. The ‘end year’ for nuclear production 2010 was arrived at by simple mathematics – our two newest reactors were planned to start commercial operations in 1985 (which was also the case).

As the financing system is designed, the timing of decommissioning activities is an important factor in the calculations behind the size of the fee. A basic assumption for these calculations has been that decommissioning activities should start as soon as technically feasible after a reactor has been taken out of operation. In the first calculations, dismantling was supposed to start in 2010 to be carried out within less than 10 years. It was also foreseen that a period of *shutdown operation* and *service operation* should follow the actual shutdown of a reactor and precede the actual start of dismantling and decommissioning. Costs for these two operational phases are included in the fees – meaning that these costs should be covered by money in the Nuclear Waste Fund.

Today the situation has changed. Swedish energy policy is still based on the assumption of a phase-out of nuclear power. But no time limit is set when phase-out should be completed. The operators are planning for a total of 40 – or perhaps 60 – years of production at most reactors and a subsequent later start of shutdown and service operations as well as of the actual dismantling and decommissioning activities. In any case, the operators argue that decommissioning cannot start earlier than 2020, because a facility for disposal of decommissioning waste will not be available until that year.

To illustrate the effect of the time factor for decommissioning activities on the calculated size of the fee, the operators have, for some years, presented two alternative scenarios as a basis for the fee calculations. It should be noted that these scenarios only apply to the methods of calculating the fees and must not be regarded as predictions of future developments of nuclear power production or of the timing of future decommissioning activities. Both scenarios are based on the current assumption of a 25-year 'earning period'.

A so-called "reference scenario" (Case A) is based on the assumption that decommissioning as a physical activity will not start earlier than after 40 years of production at each reactor. This is the scenario preferred by the operators. Referring to the provisions stated in the legislation, the regulators have requested that the operators also present a "traditional" scenario (Case B), where decommissioning would start as soon as technically feasible after 25 years of production. The exact definition of the two scenarios has changed over the last few years, but the latest definition implies, in both cases, that physical decommissioning activities will not start before 2020.

The SKB report 2004 to the Swedish Nuclear Inspectorate on expected future costs contains a graph illustrating the effects on expenditure from the Fund for these two alternatives (enclosure 9). The operators argue that an application of Case A will result in a need for lower fees per kWh than if Case B is applied; the reason being that assets that have already been collected in the Fund will provide a positive return for a longer time period than in Case B.

It seems clear that timing of decommissioning activities will affect the time during which assets in the Nuclear Waste Fund could produce a positive return. The Government committee referred to in section 2.2 is currently considering possible changes in the way the fee is calculated.

3. CONCLUSIONS

Uncertainties affecting fund collection, management and final utilisation are basic characteristics in any system aiming at providing financial resources for covering costs in the future. But the uncertainties can be reduced by being systematically identified and described and then by taking the appropriate and available measures. However, such measures may vary between different countries, depending on many factors.

Existing uncertainties are a good reason not to postpone decommissioning activities to a distant future.

It should be added that one uncertainty of major potential importance has not been discussed in depth in this paper. The reason is that this uncertainty is not particularly the business of a fund collector/manager but rather the business of all actors in a community that has established a funding system.

This uncertainty concerns the possibility that the legal rules forming the basis for a financing system are changed in a way that undermines the whole idea. A condition for a sound long-term funding system is no doubt a certain economic stability. Theoretically, a nation might get into such deep economic difficulties that existing legislation is changed to allow the use of collected funds for other purposes than originally intended.

Those who deal with long-term funding systems, such as for decommissioning, should not forget this possibility, even if it might look remote or improbable. Even a financing system that has

been constructed to be robust against identified uncertainties might fail. Who would have to bear the costs in such a case?

There will always be a temptation to pass on costs to someone else. This ‘someone’ is, in the end, the collective of future taxpayers. They are our grandchildren and their children. They certainly expect us to do better than passing on liabilities to them.

Acknowledgement

I thank O. Stångberg (MSc Economics, consultant and former Director of the Asset Management Department, the Legal, Financial and Administrative Services Agency in Sweden, ‘Kammarkollegiet’, for valuable ideas and views during the drafting of the paper.

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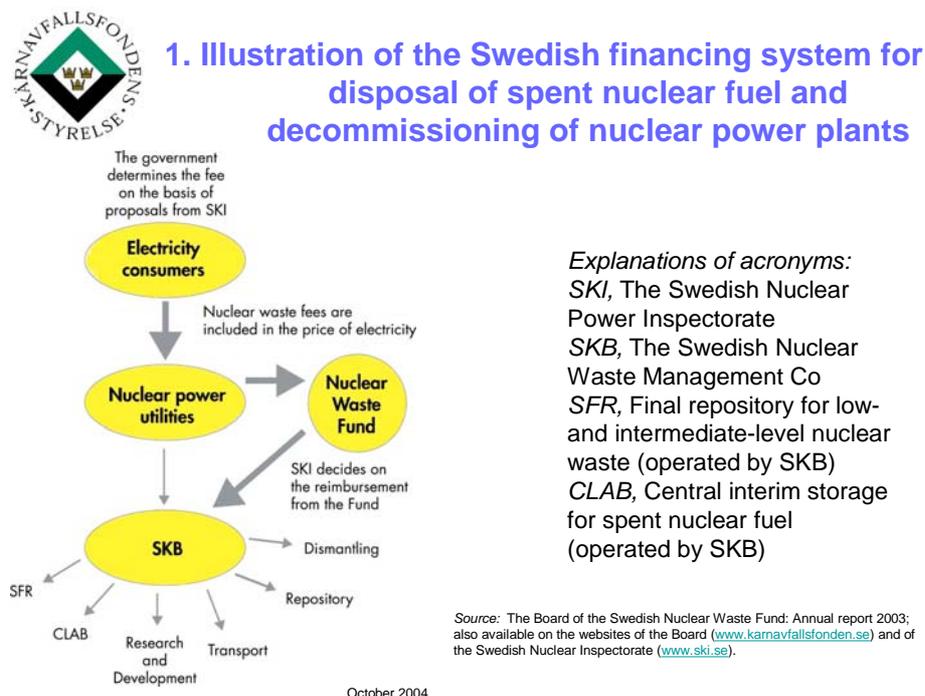
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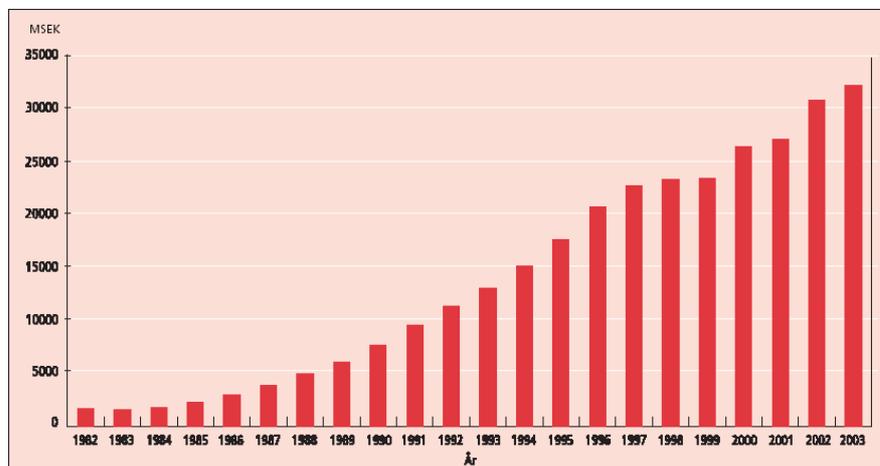
Nine illustrations and graphs

1. Illustration of the Swedish financing system for disposal of spent fuel and decommissioning of nuclear power plants.
2. The Swedish Nuclear Waste Fund 1982 – 2003.
3. Overview of income and expenses for the Swedish Nuclear Waste Fund 1982 – 2003.
4. Assets in the Swedish Nuclear Waste Fund 2003 and estimated costs.
5. Size of fees (öre per delivered kWh) paid to the Swedish Nuclear Waste Fund 1982 – 2003
6. Nominal and real returns on the capital in the Swedish Nuclear Waste Fund 1996 – 2003.
7. Guarantee I and Guarantee II 1997 – 2003 (nominal values).
8. Rough estimated development of the Nuclear Waste Fund (2004).
9. SKB's estimates of expenditures from the Nuclear Waste Fund based on Case A and Case B.





2. The Swedish Nuclear Waste Fund 1982 - 2003



Source: The Board of the Swedish Nuclear Waste Fund: Annual report 2003

October 2004



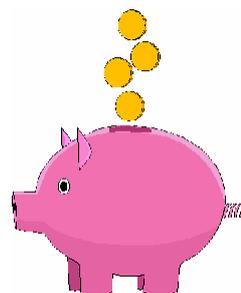
3. Overview of income and expenses for the Swedish Nuclear Waste Fund 1982 – 2003

3.1 Total results

	Bn SEK	Bn €
Total fee-based income	25	2.8
Total financial income	21	2.3
Total expenses	/.16	/.1.8
Fund assets 31 Dec 2003 (book value)	30	3.3

3.2 Results 2001 – 2003 (Million SEK)

	2003	2002	2001
Fee-based income	459	644	730
Financial income	1 478	3 706	1 655
Expenses	/. 1 087	/. 1 034	/. 859
Fund increase	850	3 316	1526



October 2004



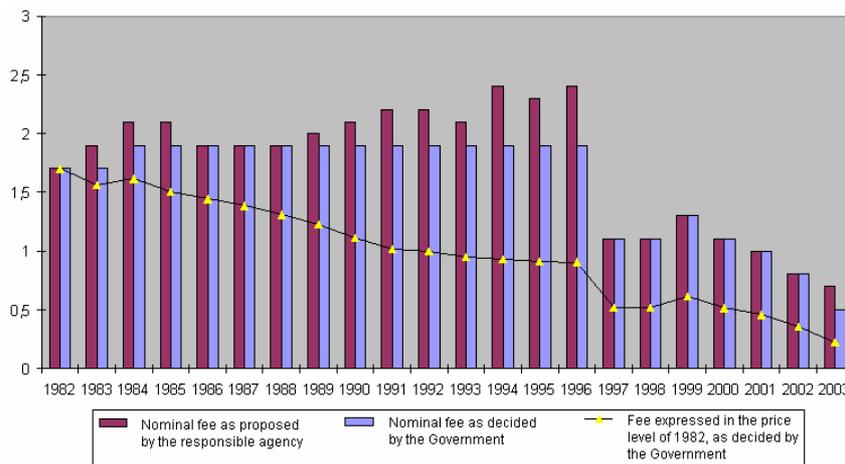
4. Assets in the Swedish Nuclear Waste Fund 2003 and estimated costs

	Bn SEK	Bn €
Fund assets 31 Dec 2003 (book value)	30	3.3
Estimated future costs 2004 – 2050's	<u>50</u>	<u>5.5</u>
To be covered by fees during remaining reactors' lifetime AND by financial income	20	2.2
Total amounts for Guarantee II 2003	3.8	0.4

October 2004



5. Size of fees (öre per delivered kWh) paid to the Swedish Nuclear Waste Fund 1982 - 2003



Source: Förslag till avgifter och säkerhetsbelopp för år 2004, SKI-Rapport 2003:39 (Proposal by the Swedish Nuclear Inspectorate to the Government on fees and guarantees for 2004, in Swedish only)

October 2004



6. Nominal and real returns on the capital in the Swedish Nuclear Waste Fund 1996 - 2003

Year	Nominal return ¹⁾ (%)	Inflation ²⁾ (%)	Real return (%)
1996	10.6	0.1	10.5
1997	9.9	1.9	8.0
1998	3.3	-0.6	3.9
1999	-0.8	1.2	-2.0
2000	12.9	1.4	11.5
2001	3.5	2.9	0.6
2002	14.9	2.3	12.6
2003	6.7	1.4	5.3
Average per year	7,6		6,2

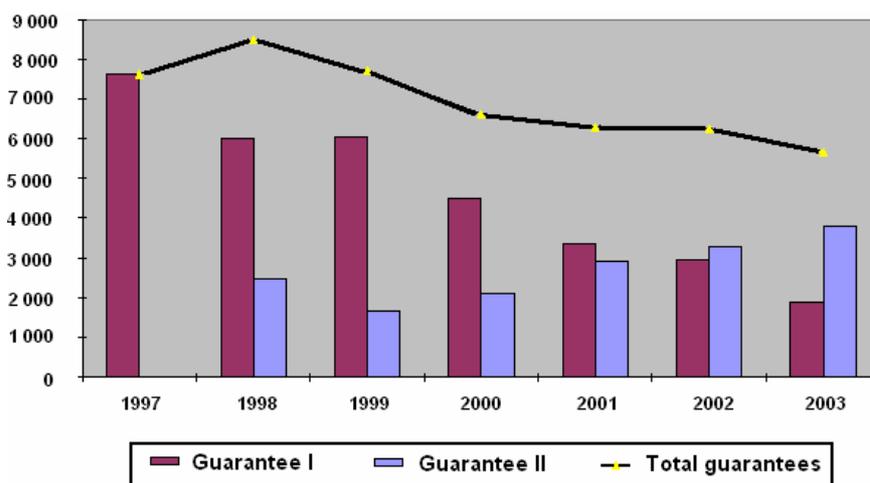
- 1) The nominal return is measured as the sum of realized and unrealized value changes in the investments as well as interest accrued (including inflation compensation on real interest investments).
- 2) Statistics Sweden's inflation index (12-month changes in the consumer price index) as at December each year is applied as a measure of inflation.

October 2004

Source: The Board of the Swedish Nuclear Waste Fund: Annual report 2003



7. Guarantee I and Guarantee II 1997 – 2003 (nominal values)

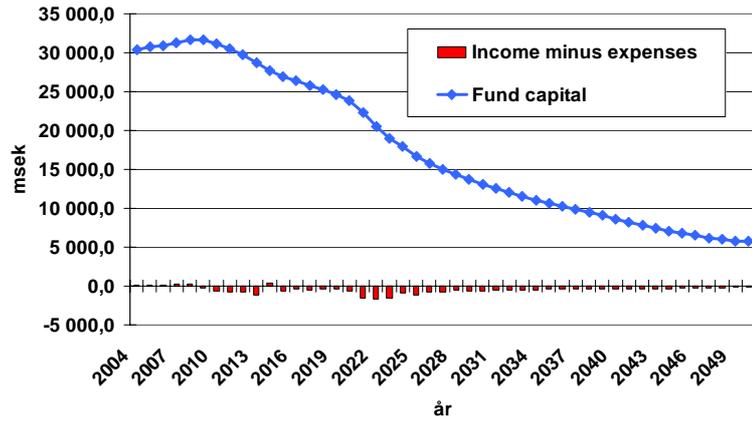


October 2004



8. The Board of the Swedish Nuclear Waste Fund: Rough estimated development of the Fund, February 2004

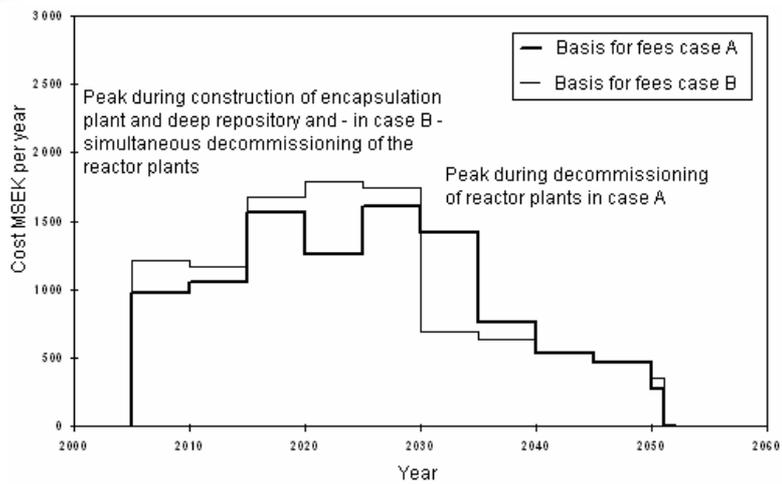
Projected fee-based incomes and expenses based on data from the Nuclear Power Inspectorate January 2004. The Board estimates real return from the Fund to be 3.25% up to year 2020, and then 2.5% (as an average)



October 2004



9. SKB's estimates of expenses from the Nuclear Waste Fund based on Case A and Case B



October 2004

Source: SKB, Plan 2004, Costs for management of the radioactive waste products from nuclear power production (published in Swedish only)

Appendix 3

NATIONAL PRESENTATIONS ON:

**GOOD AND BAD EXPERIENCES FROM THE MANAGEMENT OF EXISTING
FUNDING SYSTEMS – AND IDEAS FOR IMPROVEMENT**

SLOVAK REPUBLIC**STATE FUND OF DECOMMISSIONING OF NUCLEAR INSTALLATIONS AND HANDLING OF SPENT NUCLEAR FUELS AND NUCLEAR WASTES**

State Fund for Decommissioning of Nuclear Installations and Handling of Spent Nuclear Fuels and Nuclear Wastes was established by the Act 254/1994 of the National Council of the Slovak Republic as a special-purpose fund which concentrates financial resources intended for decommissioning of nuclear installations and for handling of spent nuclear fuels and radioactive wastes. The Act was amended in 2000, 2001 and 2002. The Fund is legal entity and independent from operator of nuclear installations Slovak Power Facilities Inc. The Fund is headed by Director, who is appointed and recalled by Minister of Economy of the Slovak Republic.

Sources of the Fund are generated from:

- a) contributions by nuclear installation operators
- b) penalties imposed by Nuclear Regulatory Authority of the Slovak Republic upon natural persons and legal entities pursuant to separate regulation
- c) bank credits
- d) interest on Fund deposits in banks
- e) grants from State Budget
- f) other sources as provided by special regulation

Fund resources may be used for the following purposes:

- a) decommissioning of nuclear installations
- b) handling of spent nuclear fuels and radioactive wastes after the termination of nuclear installation operation
- c) handling of radioactive wastes whose originator is not known, including occasionally seized radioactive wastes and radioactive materials stemming from criminal activities whose originator is not known, as confirmed by Police Corps investigator or Ministry of Health of the Slovak Republic
- d) purchase of land for the establishment of nuclear fuel and nuclear waste repositories
- e) research and development in the areas of decommissioning of nuclear installations and handling of nuclear fuels and radioactive wastes after the termination of the operation of nuclear installations

- f) selection of localities, geological survey, preparation, design, construction, commissioning, operation and closure of repositories of spent nuclear fuels and radioactive wastes, including post-closure monitoring of such repositories
- g) expenditures connected with Fund activities up to a maximum of 0,3% of annual Fund revenues

The Minister appoints Fund Council as his advisory body for generation and utilisation of Fund resources. Council members are appointed and recalled by the Minister, in particular from among experts in the fields of nuclear energy, health, environmental protection, economy and local government. The Minister at Council's suggestion decides upon granting of resources from the Fund.

The operator of nuclear installations submits applications until 15 June every year. Grants from the Fund may only be used for purposes for which they were granted. Audits of Fund management are the responsibility of Ministry of Finances of the Slovak Republic. The Prognosis for full financial support of back end of nuclear fuel cycle is compiled every other year for long-term phase (e.g. year 2130). Sources and utilisation of financial means are analysed in the prognosis, which is approved by the Government of the Slovak Republic. Outcome of this analysis defines financial contributions of operators of nuclear installations for the Fund.

Verifications of data in the table:

The Fond become active in 1995. State paid for decommissioning of A1 Power plant Jaslovské Bohunice until 2001. EC is one of the contributors for BIDSF fund. Costs for decommissioning and waste management including disposal were 3,6 Billions €

Balance in our accounts at the end of 2004 is expected to be 291, 947, 653 € Balance in our accounts as of 31 March 2004 was 317, 911, 925 €

Table 1: **Estimation of costs in mil. €**

ACTIVITIES	2004
Decommissioning NP A-1, 1. phase	6.2975
Decommissioning NP A-1, 2. phase	0
Decommissioning NP V-1	0.1875
Nuclear repository for spent fuel and highly active waste	0.7
Handling of radioactive waste	6.065
State repository Mochovce	2.09
Repository for short term placement of spent fuel /Decommissioning plant/	7.21
Other costs	5.82
SUM	28.37

OMEGA method - Oracle Multicriterial General Assessment of Decommissioning was used for calculation of costs for decommissioning of nuclear installations. The method is useful for calculations of scenarios, comparing scenarios, calculations of parameters for decommissioning and selection of optimal scenario. The method is useful for calculation of costs of back end of fuel cycle and other activities within back end of nuclear energy cycle. Outcomes of calculations are clearly comparable with other projects. The method is combined with MS Project and MS Excel.

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SWITZERLAND



Management of Existing Funding Systems in Switzerland

H. Maxeiner

- 1 Funds for D&D and Waste disposal
- 2 Organisation and payments
- 3 Investments and reporting
- 4 Final remarks

1 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

1 Funds for D&D and Waste disposal

- **„Producers pay principle“:** Producers of radioactive waste are responsible for financing its safe disposal
- **Two independent funds supervised by the Confederation:**
 - **Decommissioning fund** for nuclear facilities: Secure financial resources for D&D and for disposal of the resulting waste (not SF)
 - Established January 1, 1984 as a public law entity, Berne
 - KKB (1970), KKM (1971), KKG (1979), KKL (1984), ZWILAG (2001)
 - **Disposal fund** for nuclear power plants: Cover costs for management of operational waste and SF after decommissioning
 - Established April 1, 2000
 - Repositories: 2020 - 2050

2 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004



1 Funds for D&D and Waste disposal

- **Decommissioning fund**

- Calculation of contributions based on
 - Estimated D&D costs (taking account of cost development): first studies 1984, latest studies 2000/2001
 - Disposal of waste arising from D&D
 - Administration costs
- Latest decommissioning studies: Costs amount to 1.9 Billion CHF (pricing basis January 1, 2001)
- Annual contributions based on 40 years operation time

- **Disposal fund**

- Calculation of contributions based on
 - Management of operational waste and SF following the decommissioning
 - Transport/storage containers, transport, reprocessing and/or direct disposal of SF, conditioning and interim storage, deep geological disposal
 - Administration costs
- Latest studies: Costs amount to 12 Billion CHF
- Annual contributions based on 40 years operation time



3 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

2 Organisation and payments

- **Contributions to the decommissioning fund**

- Contributions required up to the assumed decommissioning date are converted into annual amounts
- Assumed inflation rate 3%, capital projected on a basis of 5% (net return 2% = decisive!)
- Annual contributions reviewed every 5 years (shorter periods possible in case of unforeseen events), if new operators enter or a facility is decommissioned

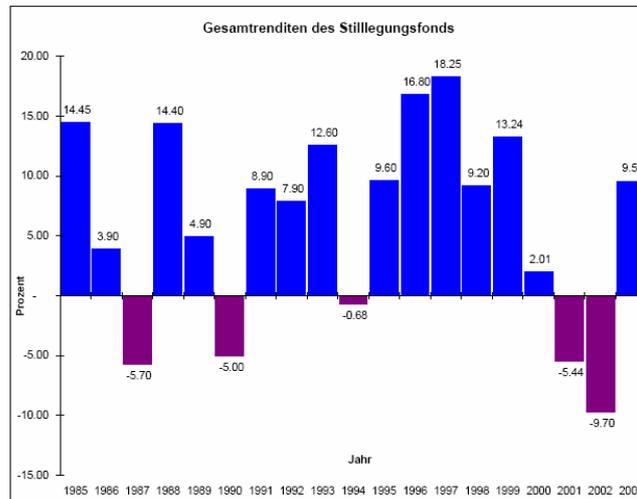
- **Fund organisation**

- Executive bodies: Management Committee and Secretariat
- MC nominated by Federal Department of Environment, Transport, Energy and Communications
- Sub committees set up by MC
 - Investment Committee
 - Cost Committee



4 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

2 Organisation and payments



Durchschnittsrendite 1985 - 2003: 5.93 % (kumulierte Rendite nach Abzug der Gebühren)



5 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

2 Organisation and payments

- **Management committee**

- 9 members (4 operators)
- Periodical determination of estimated D&D and WM costs
- Assessment of owners contributions
- Stipulation of investment policy

- **Investment committee**

- 6 members (4 operators)
- Investment strategy and guidelines -> Management committee
- Implement investment strategy and guidelines
- Selection procedures for asset managers, auditors ...
- Supervision of payment transactions

- **Cost committee**

- 7 members (3 operators and regulator)
- Calculate costs and specify annual contributions
- Deal with non-budgeted expenses



6 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

3 Investments and reporting

- **Investment concept**

- Mixed asset management mandates with identical start-up investments and guidelines given to
 - 3 (former 4) banks for Decommissioning fund
 - 10 banks
- Invest in CHF and non-CHF bonds, CHF and non-CHF equities and real estate
- Investments and compliance with guidelines monitored by Investment Committee und external experts

- **Transparent Reporting (German, French, English)**

- (Detailed) Annual reports ...
- www.stilllegungsfonds.ch
- www.entsorgungsfonds.ch
- www.nagra.ch



7 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

4 Final remarks

Nuclear Energy Act (January 1, 2005)

➤ **Producers pay**

➤ **Supplementary payments**

➤ **Confederation**



8 TS on Funding Issues/10.h, 5th WPDD-Meeting, Nov 9, 2004

SPAIN



Funding in Spain

Juan Luis Santiago (ENRESA)

11/2004

Funding in Spain



Spanish NPPs Decommissioning Strategy

- ✓ Decommissioning strategies currently considered are:
 - Immediate dismantling (for all LWR)
 - Deferred dismantling (only for Vandellós-I)
- ✓ Dismantling is assumed to commence 3 years after shutdown
- ✓ End point: Release the site for industrial uses without radiological restrictions



- 9 LWR in operation
- 1 GCR under Decommissioning

Considerations for Planning and Funding

- ✓ 40 years of lifetime for the nuclear power plants currently in operation (7.6 Gwe installed)
- ✓ Decommissioning of NPPs
 - Vandellós I: Partial dismantling (Level 2) in 2003. Total dismantling (Level 3) after a 30 years period
 - Rest of NPP's. Total dismantling (Level 3), as regards calculation and planning 3 years after final reactor shutdown

Distribution of Responsibilities

- ✓ Decommissioning is planned to start about 3 years after plant shutdown
- ✓ During this period the Utility is still responsible for the plant and should remove the spent fuel and condition all the operational wastes, prior to the transfer of responsibility to Enresa
- ✓ After transfer, Enresa is fully responsible for decommissioning

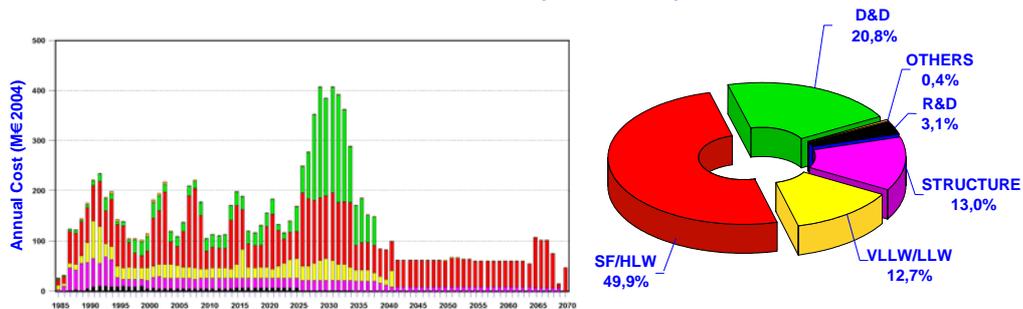
Funding in Spain

enresa

5^o General Radioactive Plan (June 2004 Rev.): Economic & Financial Aspects

Management Cost

✓ Total Cost Estimate: 12.000 M€04 (1985-2070)



✓ 24% incurred up to 2004

Funding in Spain

enresa

Decommissioning Funding and Management Rules

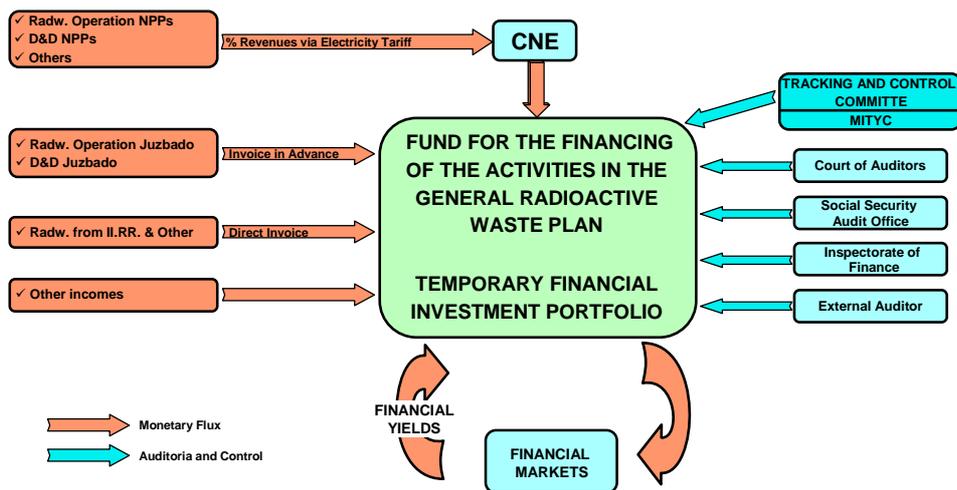
- ✓ The cost of the decommissioning of nuclear installations are financed by the producers of such wastes
- ✓ The financing of these responsibilities is by way of a Fund set up for this purpose
- ✓ The costs are calculated by Enresa by means of an annual study, which reviews the status of the techniques and assesses the associated costs, this study being submitted in the General Radioactive Waste Plan to the Ministry of Economy for its approval

Funding in Spain enresa
 Decommissioning Funding and Management Rules

- ✓ The Fund, managed by Enresa, is raised by a charge on the electricity price
- ✓ The accumulated fund is administrated by Enresa under the supervision of the competent governmental authorities
- ✓ Rules are established by a Fund Control Committee reporting to the Ministry of Economy

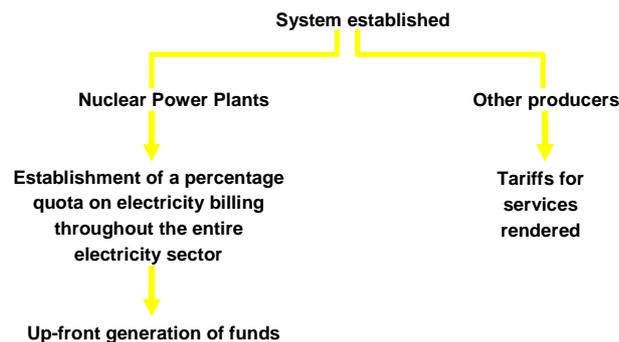


Funding in Spain enresa
 5^o General Radioactive Plan (June 2004 Rev.): Economic & Financial Aspects



Financing via electricity Billing

The costs of activities arising as a result of radioactive waste management are to be financed by the producers



The total amount obtained electricity tariff, plus the corresponding financial yield, shall cover the following costs:

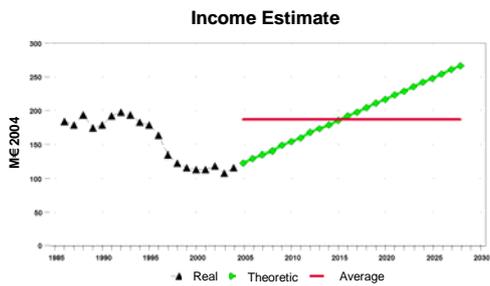
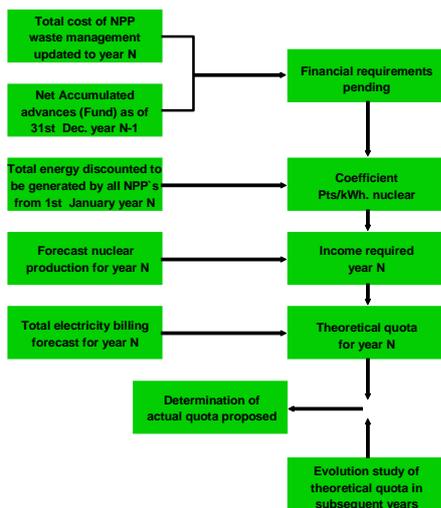
- ✓ The management of radioactive wastes generated during electricity production by nuclear means from the origin
- ✓ The management of radioactive wastes arising from research activities that, in the opinion of the Ministry of Economy, have been directly related to electricity production by nuclear means
- ✓ The D&D of nuclear electricity generating facilities, as well as management of the resulting radioactive wastes
- ✓ The D&D operations carried out as a result of uranium mining and milling activities performed prior to the constitution of ENRESA
- ✓ Other costs to be incurred by ENRESA for the performance of its missions in relation to the activities set out above

Funding in Spain enresa
 Financial Parameters

- ✓ The Fund has to be provided during the operating lifetime of the nuclear power plants
- ✓ The Fund includes provisions for waste/spent fuel management and decommissioning
- ✓ The Fund required is based on Discounted Costs:
 - Base Year: 1999
 - Inflation Rate: 2%
 - Discount Rate: 2.5%



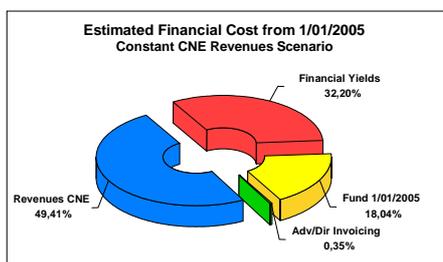
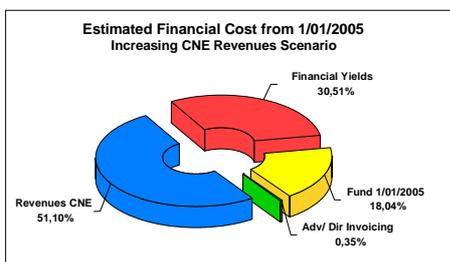
Funding in Spain enresa
 5^o General Radioactive Plan (June 2004 Rev.): Economic & Financial Aspects



Funding in Spain **enresa**
5^o General Radioactive Plan (June 2004 Rev.): Economic & Financial Aspects

M€ 2004

- ✓ Radwastes Management Total Costs12,000
- ✓ Radwastes Management Total Cost (from Jan/2005).....9,115
- ✓ Radwastes Management Total Cost (from Jan/2005), on a Discount Rate of 2.5%.....5,022
- ✓ Accumulated Fund (Jan/2005).....1,644
- ✓ Estimated Cost to Finance.....3,378



Appendix 4

NATIONAL PRESENTATIONS ON:

**WHAT IS DONE TO ENSURE THAT FUNDS WILL BE AVAILABLE WHEN NEEDED?
POSITIVE AND NEGATIVE EXPERIENCES IN EXISTING SYSTEMS**

FINLAND



What is Done to Ensure that Funds will be Available when Needed? Positive and Negative Experiences in Existing Systems - Finland

The Finnish system

- waste producer is responsible
- all waste management including decommissioning is covered
- fund is a guarantee and a way to include future costs in the price of electricity
- fund covers future costs of existing wastes, thus liabilities are re-evaluated annually
- present day technology and costs are used, no discounting
- segregated fund, waste producer can borrow back 75%, State can borrow the remaining 25%

11/2004/JPP

Topical session on funding issues in connection with decommissioning of nuclear power plants,
OECD/NEA/RWMC/WPDD, November 9, 2004

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What is Done to Ensure that Funds will be Available when Needed? Positive and Negative Experiences in Existing Systems - Finland

Measures included in the system to ensure the sufficiency and availability of funds

- uncertainties have to be accounted for
- additional 10% security over the total liability is demanded
- the part of liability not yet in the fund as well as loans have to be covered with securities
- the profit of the fund covers the inflation
- annual reviews of plans and cost estimates

11/2004/JPP

Topical session on funding issues in connection with decommissioning of nuclear power plants,
OECD/NEA/RWMC/WPDD, November 9, 2004

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**What is Done to Ensure that Funds will be Available when Needed?
Positive and Negative Experiences in Existing Systems - Finland**

Other measures to ensure the sufficiency and availability of funds

- **comprehensive legislation, well-defined responsibilities**
- **well-defined policy, programme and milestones**
- **programme proceeding in schedule => largest waste management investments will be made during NPP operation**
- **detailed technical plans and designs, decommissioning plans updated every 5 years, cost estimates based on NPP specific plans**
- **independent reviews of cost estimates of different waste management components**

11/2004/JPP

Topical session on funding issues in connection with decommissioning of nuclear power plants,
OECD/NEA/RWMC/WPDD, November 9, 2004

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**What is Done to Ensure that Funds will be Available when Needed?
Positive and Negative Experiences in Existing Systems - Finland**

Experiences

- **the annual changes in the liabilities have in most cases been within the assumed uncertainties**
- **the realised costs of the existing waste management facilities have been reasonably close to cost estimates**
- **the demands of secure investments and above inflation profits are sometimes contradictory**

11/2004/JPP

Topical session on funding issues in connection with decommissioning of nuclear power plants,
OECD/NEA/RWMC/WPDD, November 9, 2004

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FRANCE

Working Party on Decommissioning and Dismantling

What is done in France to ensure that funds will be available when needed ?

09/11/2004

Arnaud LOCUFIER & Jean JAVANNI

Sub-directorate for Nuclear Industry

Directorate for Energy and Mineral Resources



Background

☞ **3 nuclear operators in France :**

- EDF
 - AREVA
 - CEA
- which bear the responsibility for the nuclear long term liabilities (D&D, nuclear waste long term management).

☞ **& a national agency for radioactive waste management (ANDRA)**

☞ **Supervision of the operators by the Government Departments**

☞ **Regulatory control of safety through the Nuclear Safety Authority (ASN)**



Nuclear operators' responsibilities

	Decommissioning and Dismantling	Radioactive Waste Management
Technical point of view	EDF, CEA, AREVA	ANDRA
Funding	EDF, CEA, AREVA	EDF, CEA, AREVA



	Decommissioning and Dismantling	Radioactive Waste Management
Amount of reserves	Estimated costs of the D&D operations Periodic reevaluation	For LLWs and MLWs : commercial contracts For HLW - LL : ANDRA estimation of a deep geological disposal



Funding

- ☞ **No legal requirements for the operators to create a specific fund for D&D and waste long term management.**
- ☞ **However, EDF, AREVA and CEA already set up funds with specific assets.**
- ☞ **These funds are managed by the companies, supervised by a special committee (CEA and AREVA) which play an advisory role for the Board of Directors.**



Evolutions

- 📄 **Open competition on European electricity market**
- 📄 **Evolution of EDF status**
- 📄 **AREVA could go public**
- 📄 **2006 debate on HLW-LL long term management**

➔ *It is essential to redefine the French approach.
The time constant is quite long.
A European frame could be used.*



France Favours a Harmonised European Legal Frame

- 📄 **France shared the intentions of Mrs. De Palacio in launching the “Nuclear Package”.**
(continuation to the Green Paper)
- 📄 **France favoured the inclusion of the dismantling issue in this Package:**
 - Lack of provisions on this issue is a matter of concern.
 - Mandatory segregation of funds is not suitable for all MS.
 - A balance had been found.

➔ *But the Nuclear Package has not been voted:
Council Conclusion of 28 June 2004.*





Member States to work together in a “Bottom-Up” Approach

 **Commission issued its report 3 Nov. 2004.** *COM(2004)719*

 **Pending legal issues:**

- Legal base for European legislation: safety (Euratom) or competition law (EC)?
- Where/which are State Aids that may distort competition?

 **Support an “Action Plan” for the implementation of the Conclusions of the Council.**
(towards 2006-2007)

↑ France is committed to come to a European consensus on the implementation of the following:

“to ensure that adequate financial resources are available as to cover when needed the decommissioning costs”.

Financing system

- **Basic Principle: Polluter pays**
- **Publicly funded facilities (mainly Federal Government)**
 - payment from annual budget
- **Privately owned facilities**
 - collection of "reserves" during operation / linear accumulation over 25 years
 - coverage: processing, storage and disposal of radioactive waste/spent fuel
D + D of nuclear facilities
 - reserves are in the portfolio of industry [30 - 35 · 10⁹ € incl. disposal]
 - financial risk lies with the operator
- **Availability of private funds**
 - annual review / revision of the cost calculations by the operator
 - review of cost calculations by tax authorities

| Verantwortung für Mensch und Umwelt | ■ ■ ■ ■ ■ ■ ■ ■ ■ ■



3

Costs

- **Cost calculation**
 - by the operator
 - are based on detailed planning
 - need to be assessed conservatively [HGB § 252 (1) 4]
- **D + D cost calculation (as of 1999):**
 - ca. 300 · 10⁶ Euro 1200 MW PWR (excl. disposal)
 - ca. 350 · 10⁶ Euro 800 MW BWR (excl. disposal)
 - ca. 700 · 10⁶ Euro (incl. disposal of non-heat generating waste)
 - immediate dismantling is slightly cheaper than deferred dismantling
- **Review and decision on adequacy of cost calculation by tax authorities**

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4

ITALY



Summary

- **Statement**
- **Strategy for decommissioning**
- **Previously existing fund**
- **Regulatory aspects**
- **Funding mechanism**
- **Present situation**



Statement

- In Italy, as it is well known, there are no more operational NPPs.

The four existing nuclear plants are definitely shutdown and ready for decommissioning:

Caorso - BWR - 860 Mwe

Garigliano - BWR - 160 Mwe

Trino - PWR - 260 MWE

Latina - GCR - 153 MWe

Considerations on decommissioning funding system have to take into account this particular situation



Strategy for decommissioning

- New inputs given to SOGIN by the Italian Government are:

- 📖 conditioning all radioactive waste existing on the NPPs within the year 2010

- 📖 release all nuclear sites – free of radiological constraints - by 2020

- The last task is conditioned by availability of the national waste repository by the year 2009



Strategy for decommissioning

- Key issue is prompt dismantling considering:

- No more nuclear activities in Italy
- Progressive loss of competences



Previously Existing funds (1)

- Before plant shutdown, ENEL has cumulated provisions for decommissioning, even in absence of a clear regulatory framework. These provisions were not sufficient for decommissioning, considering the early closure of the plants.
- An additional fund was granted to ENEL by the government, in the form of a "credit" to be paid by the "electric system" (CCSE).
- This fund (provisions + credit) was considered sufficient by ENEL for a decommissioning with Safe Store strategy (fund = discounted foreseen costs)



Previously Existing funds (2)

- ④ The total fund (provisions + credit) was assigned to Sogin at the incorporation date. The amount, money 1999, was about 800 M€
- ④ Considering the new context:
 - new strategy (Prompt Dismantling with site release by 2020)
 - Sogin constitution (societal costs)
 - new economic conditionsthe fund was not considered sufficient for all Sogin tasks
- ④ This conclusion was agreed upon also by the independent "Authority for electric energy and gas".
- ④ A new regulatory framework was therefore defined



Regulatory aspects (1)

- ④ The Legislative Decree 79/99 has stated that costs for the decommissioning of NPP, fuel cycle back end and *related activities* should be considered as stranded costs for the general electric system
- ④ The same Decree stated that a specific company should have been established for the management of these activities. Consequently, Sogin has been incorporated, all nuclear assets and liabilities of Enel being assigned to the Company. Sogin is responsible for decommissioning and fuel back end, under the policy indicated by the Government



Regulatory aspects (2)

- The Ministerial Decree 26.01.2000 precisely defined which costs can be considered as stranded costs. As a matter of fact, the decree confirms that all costs incurred in by Sogin for decommissioning, fuel cycle back end, wastes disposal are to be considered.
- The same Decree defines modalities for funding Sogin for the above mentioned activities.



Regulatory aspects (3)

- The same Decrees define that in the "*related activities*" the dismantling of research plants for the nuclear fuel cycle should be considered. These plants are now property of Enea and FN.
- The Decree defines modalities for funding Sogin for the above mentioned activities. Sogin is entitled to receive also the funds for the decommissioning of Enea plants, providing a Consortium with Enea.



Funding mechanism (1)

Main Criteria:

- **Costs are financed with a levy on the price of kWh for final consumers**
- **The amount of the levy, for different categories of consumers, is defined by the "Authority for electric energy and gas"**



Funding mechanism (2)

Regulatory procedure:

- **Sogin presents to the Authority, each year by Sept. 30th, a complete program with scheduled activities and cost estimates for the overall project. Present estimates consider a global cost of about 2600M€ for power plants and 630 M€ for Research plants (constant money 2002)**
- **The Authority, every three years, determines the total amount of the expenses on the basis of Sogin documentation, taking into account efficiency criteria. Annual re-considerations are possible if major events occur**
- **On this basis, the Authority defines the amount of the levy**



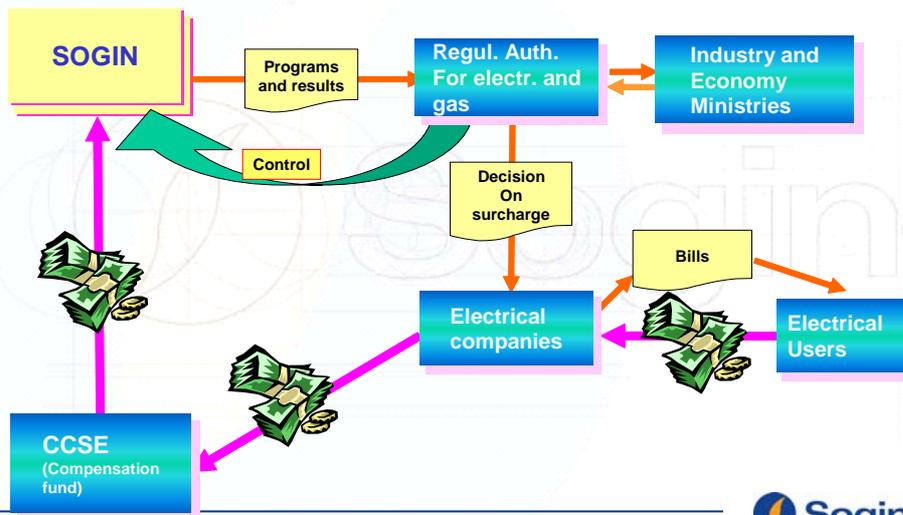
Funding mechanism (3)

Monetary flow:

- Distribution companies pay the related amount to a central Body (CCSE)
- CCSE pays, every two months, the due amount to Sogin.



Funding Mechanisms through the electrical bill



Present situation (1)

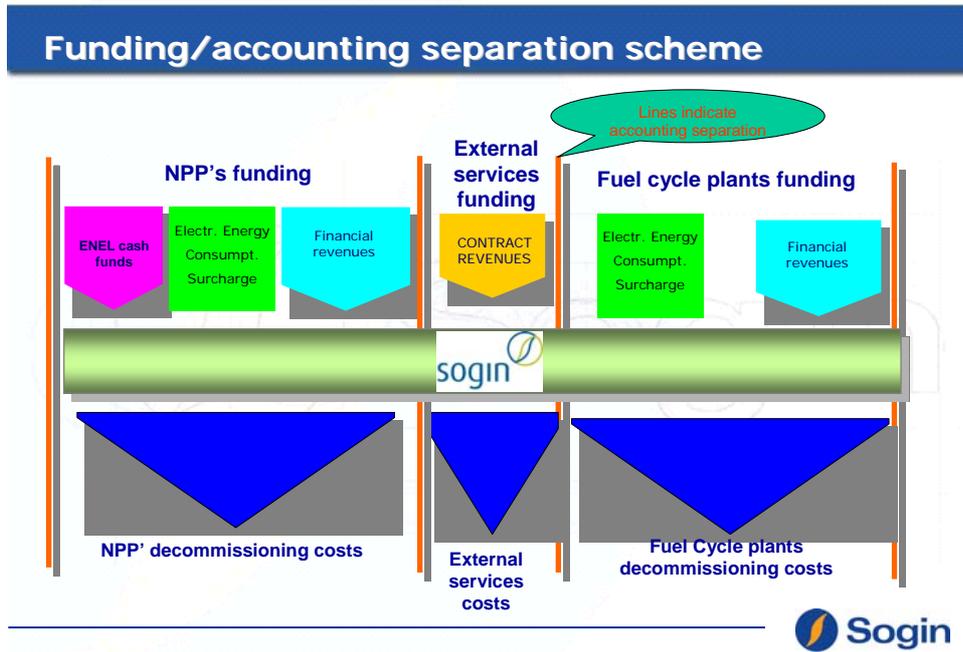
- In early 2002, the Authority issued the first resolution for the determination of decommissioning costs
- Specific reference was made to costs foreseen for 2002-2004, in the general context of the pluriannual program. The Authority endorsed the cost estimates of Sogin
- A global levy of about 0,06 eurocents/kWh is now established; the annual income for Sogin (and Enea) is about 150 M€



Present situation (2)

- In summary, Sogin has today a decommissioning fund that is built by two parts:
 - the provision (cash) assigned from Enel (about 400 M€)
 - a credit towards the “electric system”, corresponding to the expenses foreseen in next three years period (about 350 M€).This credit shall be re-determined every three year
- It is expected that in the medium term decommissioning costs shall be covered by re-determined credits for successive three year periods
- The cash part of the fund shall be used in the long term



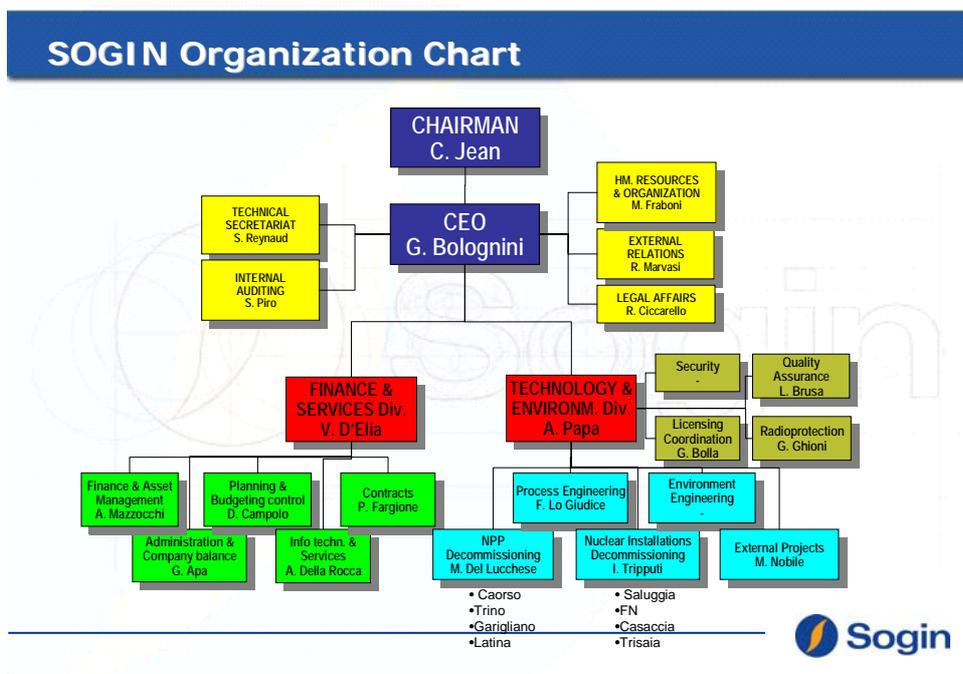
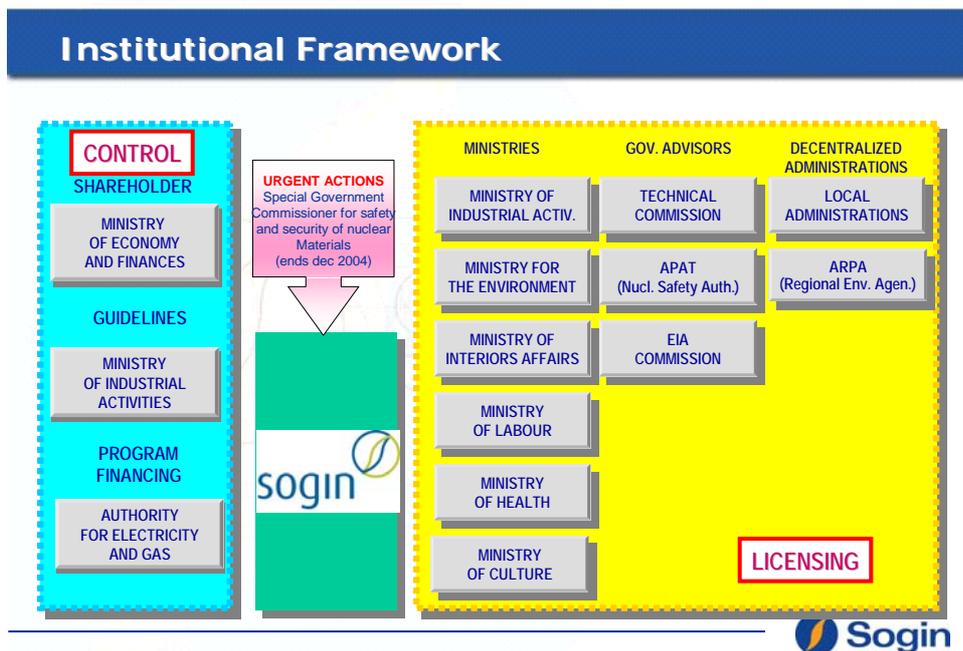


Present situation (3)

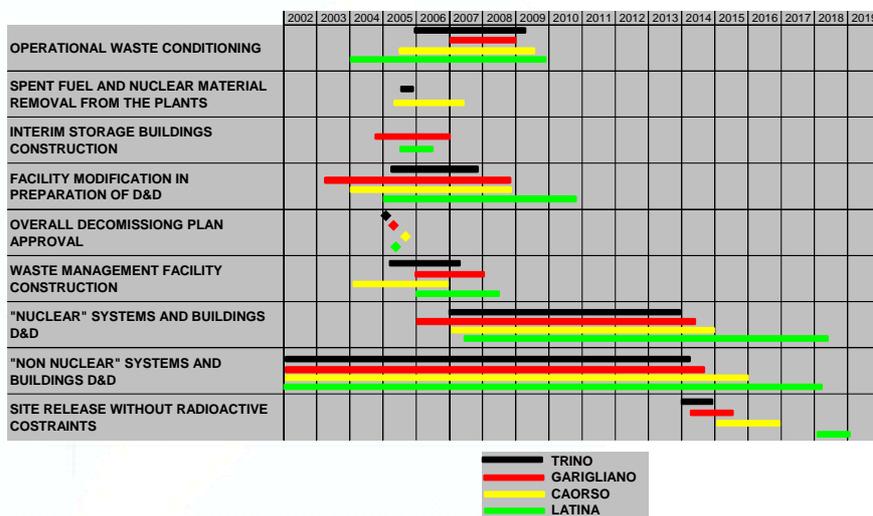
- The "cash" part of the fund is managed by Sogin according to guidelines issued by the Ministry of Economy. At the moment only low risk investment are allowed.

Sogin

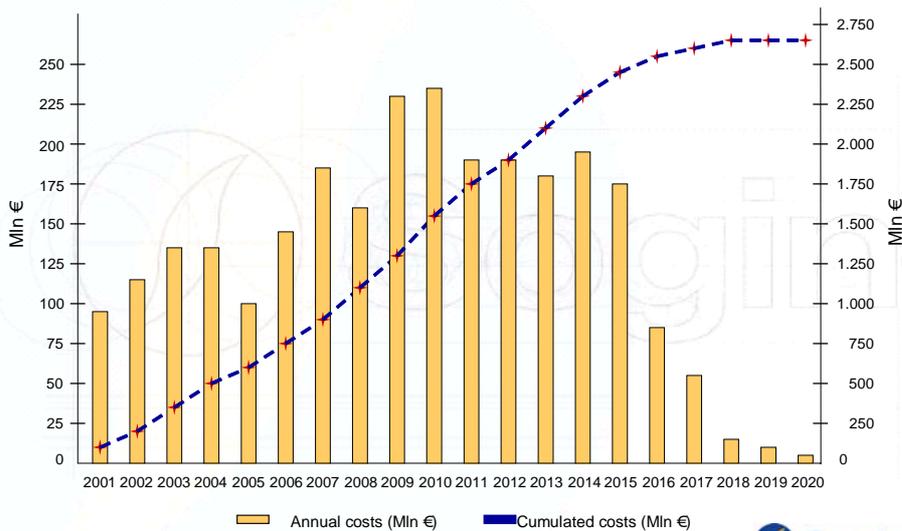
Sogin



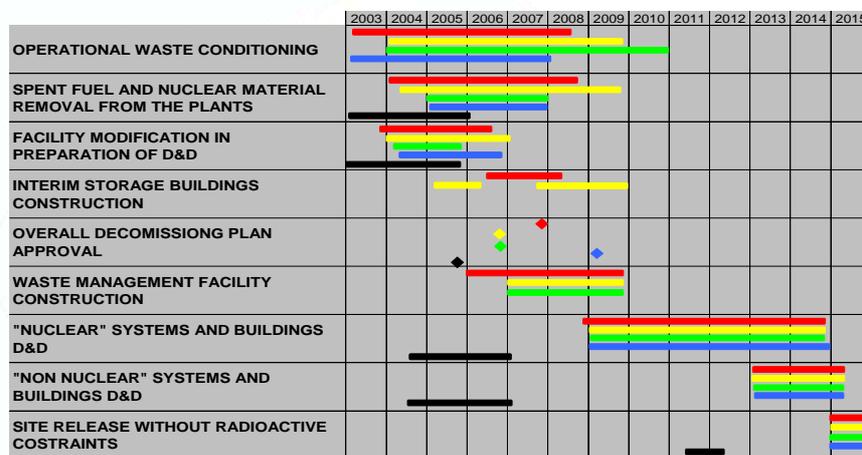
NPP's Decommissioning Programs



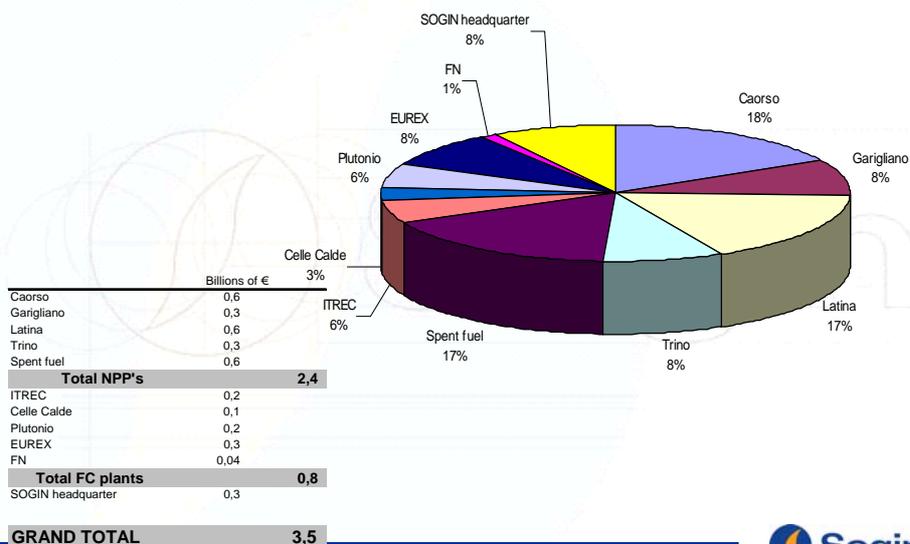
Power plants decommissioning costs



Fuel Cycle Plants decommissioning Program



Costs breakdown



UNITED KINGDOM



Funding Decommissioning – UK Experience

Gordon MacKerron
Associate Director

8 November 2004



Up To 1990

- 'Funding' started with CEGB and SSEB (state-owned electric utilities) in 1976 using the internal unsegregated fund route (i.e unfunded).
- This continued until privatisation of electricity industry (excluding nuclear) in 1990. Assets bought with the internal unsegregated fund were mostly transferred into non-nuclear private utilities.
- New state-owned Nuclear Electric (England and Wales) was given a 'Fossil Fuel Levy', a consumer charge of 10% on retail bills, amounting to c. £1bn. annually. This allowed Nuclear Electric to trade legally (A reserve of £2.5bn. was available from Government if company ran out of money).

Nuclear Privatisation

- By 1996 the newer nuclear stations (AGRS plus PWR) were privatised as British Energy. British Energy started an external segregated fund, the Nuclear Decommissioning Fund, with a starting endowment of c. £225m. - and BE made annual contributions of £16m. into the Fund. Assumptions were that BE had 70 to accumulate cash and could get a 3.5% average annual real return.
- Older stations (Magnox) were left in private sector and went to BNFL in 1997. Magnox inherited the surplus cash in BE - mostly unspent Fossil Fuel Levy receipts - of c. £2.6bn. Government gave an 'Undertaking' to pay £3.8bn. (escalating at 4.5% real annually) for Magnox liabilities, should Magnox Electric run out of cash. BNFL inherited the £2.6 bn. and by 2000 had a 'Nuclear Liabilities Investment Portfolio' of c. £4bn. This was a quasi-segregated internal fund for liabilities in general. [Note: overall UK nuclear liabilities in civilian sector were running at c. £48bn. by now].

NERA Economic Consulting

3

British Energy

BE started profitable and paid £100m. annually in dividends to private investors for several years. BE ran into severe financial problems after 2001 and Government organised restructuring aid, now approved by European Commission. Terms include:

- BE now to contribute £20m. a year into an expanded Nuclear Liabilities Fund
- A bond issue of £275m. to go to Fund
- 65% of all BE free cash flow to go to the Fund
- Government would pay for all Stage 1/2/3 decommissioning expenses that BE could not meet.

NERA Economic Consulting

4



British Energy

BE is still a private company in a formal sense but the UK Office of National Statistics classifies it as a public sector company, because it regards control (not ownership) as in State hands.



NDA

- Government is now setting up the Nuclear Decommissioning Authority (NDA) to manage all public sector liabilities. Intention was to have a 'segregated account' to help give assurance that funding would be long-term and reliable. First draft Annual Plan does not mention segregation or any funding commitment beyond the first year (2005/6). The BNFL NLIP will presumably go to the Treasury.
- NLIP will presumably go to the Treasury.

Conclusion

In conclusion, it is clear that the decommissioning funding system has been short-term and has relied mainly on Government. Some consumer contributions have been made, but now that nuclear power competes in a private market place and is relatively expensive, there is no guarantee that consumers/polluters will pay for a significant proportion of future decommissioning costs.