Managing spent nuclear fuel: What is the purpose?

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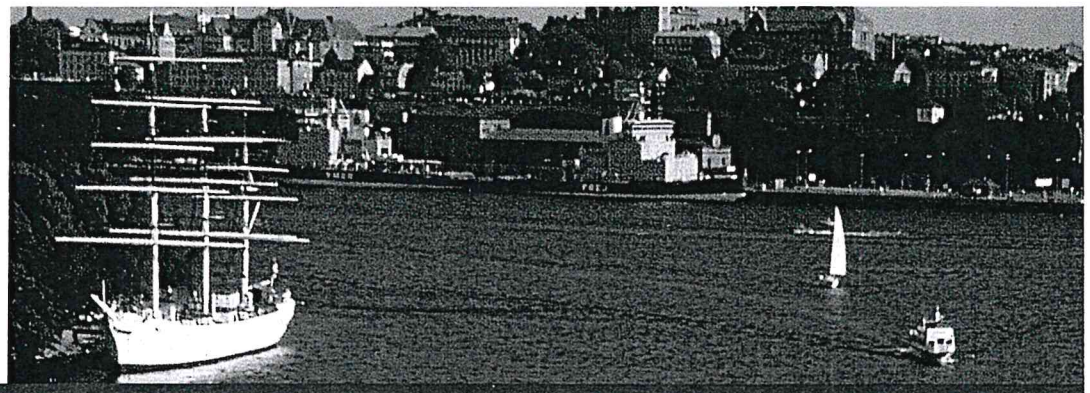

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Managing spent nuclear fuel: What is the purpose?

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Abstract

Spent nuclear fuel may be considered a resource for further production of electricity or as a source of materials for nuclear weapon production. It may also be seen as a toxic waste that may be misused for radiological terrorism or the production of nuclear explosives. Different assessments of the relative importance of different perspective may lead to very different waste management strategies. Very different perspectives may also lead to agreement on early stages of waste management while disagreement will be revealed at later stages.

In order to facilitate a transparent decision making process the purpose of waste management must be made clear. From the defined purpose, the relevance of facts, arguments and counter arguments can be assessed. Having a clearly defined purpose will also show the what needs there are to define the distribution of economic liabilities for possible costs among different actors

The economic, social and ideological stake-holders involved in the decision making process are unlikely to reach consensus. However, making the clarification's suggested above will serve the purpose of revealing the rational interests behind what presently is interpreted as real – or imagined – hidden agendas of the actors in the process.

1. Introduction

Managing nuclear waste in general and spent fuel in particular is important because the processes will use large amount of economic resources. At the same time miss-management could lead to enormous economic and social consequences, especially via the possible deliberate use of nuclear waste for destructive purposes.

I have been involved in the debate on nuclear waste for some 10 years. I always dislike nuclear weapons, and I am told I am against nuclear power because I have said reactors should not be used if they can not compete when paying their costs.

But, as you may understand from what follows, I am not very impressed by any position in the nuclear waste debate. As with the politics of nuclear power, one may suspect that unclear policy may cause more damage than a clear but wrong policy would.

So, my point is that the policy analysis should be made explicit and clear decision taken.

2. Introducing some perspectives on spent fuel

The following are descriptions of possible perspectives on the context and purpose of the management of spent nuclear fuel. None of them is complete. None of them corresponds to any position the author would like to defend as such.

2.1 Nuclear power for the future

The rate of extraction of oil and gas is close to the point where the rate of extraction will start to decrease. Oil and gas may well be extensively used for another 50 to 100 years but the rate of oil and gas extraction cannot increase to make up for the increased demand. (Campbell 1997) There are good reasons to expect demand to rise because of continued growth of economic activity in the industrialised world, in Asia, in central and east Europe and in the developing world. In particular there will be a rapid increase in demand for electricity spurred by the desire for in-door climate control in hot countries close to the equator, and the increased paying capacity to satisfy such desires.

Coal, the fossil fuel available in large amounts, has several severe environmental problems connected to its use. Coal mining, air-pollutants causing acid rain and health effects, and most notably the emissions of greenhouse gases, both methane from mining and carbon dioxide from the combustion process itself. These emissions, even the emissions of carbon dioxide, can be controlled but modern technology. But the costs, partly as loss of net energy yield, may be so high that coal is unlikely to provide for the increased demand for energy.

Of the energy sources available with tested technologies only nuclear power has proved able to provide sufficient amounts of electricity to satisfy a rapidly growing demand. Thus, even if the expansion of nuclear power is now at a temporary stand

still, within a few decades nuclear power should once again be a growing business and the demand for fissile materials dramatically increasing.

With an increase in demand for nuclear fuel, uranium resources must be used efficiently. Reprocessing spent fuel appears to be desirable as the world cannot afford to dispose fuel rods still containing significant amounts of suitable fissile materials.

From this perspective, spent nuclear fuel should be stored in an environmentally safe way with minimum cost of retrieval. The time span of the environmental safety analysis need not be more than decades or centuries. Surface storage or under ground repositories designed to make retrieval possible appears as desirable.

2.2 Moralist anti-nuclear

From a different perspective nuclear power may be ruled out as a future energy option for two reasons. Nuclear reactor accidents may cause damages so large that it is not acceptable to deliberately introduce even the possibility of such a catastrophe. Producing nuclear waste will impose a risk and possibly an economic burden on future generation long into the future. To produce electricity for economic consumption far beyond basic needs, in such a way that it may harm generations far into the future – that may well be far poorer than present consumers of nuclear electricity – is morally unacceptable.

To place the waste we have produced in repositories in such a way that our own and the next few, generations will not have to bother about the problems may create an illusion that the waste problem is solved. Establishing that illusion may, in turn, encourage our generation to increase the waste production further, at the cost of future generations' health and opportunities to satisfy their basic needs.

Instead, more research must be done to develop waste management systems that are perfectly safe for coming generations. With this ambition in mind, spent nuclear fuels must, while further research is done, be kept environmentally safe but clearly within reach and responsibility of the present generation.

2.3 Situationist Cost-Benefit perspective

From the perspective of the economic planner, spent nuclear fuel is just one in a series of societal waste problems, in line with stable and toxic heavy metals as well as many highly dangerous products of the chemical industries. Efforts should be made to manage spent fuels so as to avoid costly damages as long as the costs to reduce the future risks as less than the environmental damages that are avoided. Spending more resources to manage nuclear wastes would be harmful as resources used to manage nuclear wastes could have been used for greater reductions of the damages from other wastes, or for economic investments to increase the economic well-being of future generations.

Operators of nuclear reactors should not have to bear the full economic burden of potential long-term effects, while other industries do not, as this implies an unfair competitive disadvantage.

Repositories must last longer that the companies responsible for producing the waste. But the long-term characteristics are of no economic significance

2.4 Strategist global security

The era of nuclear power have passed its peak. The total cost of electricity from nuclear reactors has proved so high that nuclear power will not be a viable alternative. Before any new nuclear reactors are profitable a combination of improved energy efficiency and energy from renewable resources will fill the gap between an increasing demand for energy-services and the remaining fossil fuel use. Scenarios of this kind are described by (Johansson, Kelly et al. 1993). New reactor concepts relying on external neutron sources, breeder reactors or fusion reactors can not develop technologically, nor economically, fast enough to find a time window of competitive advantage before technologies for direct use of solar energy will have appeared at low costs with large potentials.

For hundreds of generations into the future the fissile materials produced by reactors during since the middle of the 20th century will be an available source of materials for any organisation desiring nuclear explosives (Peterson 1996) or radiological weapon of mass destruction. The consequences of deliberate damages are greater than any potential effect of leakage into the natural environment. Therefore, the most important function of a system for the management of spent nuclear fuel is the long-term ability to resist attempts to recover the fissile materials for destructive purposes.

The perspective was discussed by (Swahn 1992)

2.5 Geopolitical power strategist

The nuclear reactors were established so that they could produce fissile materials useful for national defence. This was the case in Sweden (Larsson 1985) (Lindström 1991), and has been so in other countries as well. As nuclear power projects are difficult to justify on economic ground, hidden weapon projects are important reasons in any country developing reactors today. Even though the military applications are not always of short-term interest, keeping the fissile materials available is strategically valuable and in the interest of the nation. As other countries plan in this way, so must we do.

Looking at the waste as a resource in the struggle between nations, the spent fuel should be managed in environmentally acceptable ways, but plutonium must not be exported, nor disposed of in any irretrievable way.

2.6 Market facilitators

Regardless of previous regulations, fair competition in the future requires that any waste producer is paying the total cost of the waste – that includes both

management costs and future damages caused by the managed or unmanaged waste. To ensure payments an obligation to pay is not sufficient, an obligation to guarantee paying capacity long into the future is also required.

An important government task is to establish an institutional framework assuring that the producers of nuclear waste will also in a just way be made to pay for any damages caused by the waste – also statistical effect where the individual victim cannot be identified.

Such arrangements would not only contribute to fair competition, but maybe more importantly, to more efficient search for best possible information and understanding of the problems of long-term waste management. (Kåberger 1992) (Kåberger 1993)

Waste need not be kept perfectly safe, repositories may leak, but all damages, as well as all management costs, should be paid for by those produced the waste. Weapon material aspects are hardly relevant in this economic perspective.

3. The process may proceed with varying majorities

There is no clear specification of the purpose of managing spent nuclear fuel in Sweden. To my knowledge there is no clear specification in any other nuclear reactor country either. There may be at least two reasons for that. First of all there is a fundamental uncertainty about what may be technologically achieved. Secondly, it is well known that there are several different ambitions in society about what the purpose is with spent nuclear fuel management. None of them has a clear political majority behind it. Thus it is considered constructive to be vague. As long as being vague make it possible to collect a majority behind the short term steps.

As the Swedish government yearly define what the nuclear power inspectorate should ensure regarding nuclear waste. The government, last year, said that final storage of spent nuclear fuel should be such that "possible leakage of radioactive substances during different time-spans may be expected to be below tolerable levels, so that coming generations are not exposed to greater risks to their health and environment than what society today tolerates." (Instructions to SKI , section 1.1, point 4).

But the aims are not only vague in a quantitative sense. There are fundamental issues that are resolved on stable grounds.

The idea that nuclear waste shall be managed nationally is supported by geopolitical power strategists, as well as by anti-nuclear moralists. Nuclear for the future groups may also see the national responsibility as a suitable tactical position

in the short term. From any of the economic perspectives there is no reason why waste managers should not be allowed to make use of differences in physical conditions that make it easier to build stable repositories in some countries than in others. From a strategic, global security perspective, it may be desirable to centralise management of fissile materials to a few sites to make safeguarding easier.

What is today a stable majority may not hold if the use of nuclear power clearly declines. If, on the other hand, nuclear power started to increase globally national strategies would also erode, as the reprocessing system would create a global market. Such a market would be difficult to combine with the national obligations supported today.

Retrievability is presently supported by anti-nuclear moralists, nuclear for the future proponents, as well as geopolitical power strategists. Once again, this majority is not stable. If nuclear looses in the future competitive markets the anti-nuclear moralists have no reason to be interested in keeping the waste easily accessible. If nuclear instead would be gaining there is no strategic case for safeguarding the repositories for the non-fissile wastes after reprocessed spent fuel. At the same time the proponents of retrievability among those favouring nuclear for the future and geopolitical power strategists will also dissolve. Maybe the fears of radiological weapon terrorists will motivate most actors to favour that non-fissile remnants of the nuclear reactor fuels are indeed stored in such away that retrieval is extremely difficult.

The idea to take on a national physical responsibility for the waste seem to be one that will not hold many decades into the future – whatever happens to nuclear power. This is well known in Sweden. It is interesting to note how this was dealt with in the Swedish accession agreement to the European Union. A special joint statement was written. It could be referred to as upholding the national responsibility and sovereignty, while in fact is will in no way stop any future trade in spent nuclear waste for management from or to any other country, at least not within the Union

The problem is that from an economic perspective the process to decide how to manage the waste may cost more than the waste management itself. In a brilliant little article from 1979, Svante Beckman lists key points if you want to create a real failure, not just a mistake. (Beckman 1979). In short they may be described by the following list:

1. Define vague aims, possibly several and contradictory aims, and let their relative importance change with time.
2. Control the feed-back system.
3. Have flexible time schedules.
4. Be near the research front.
5. The project should be expressive, not just practical.
6. There should be the prospects of a great leap, when things will start to happen.
7. Create problems to solve.

8. Envision that a turning point is ahead, from that on things will go well.
9. Ensure a monopoly to avoid benchmarking.
10. Let other, spin-off results justify the continued process.

Considering the large scale of the industrial projects to manage spent nuclear fuel, another provoking book for studying is Great Planning Disasters (Hall 1980). Here, projects like the Concorde ultra-sonic flight project show similarities. In this project the co-operation between Britain and France came to become more important in this project than the result. Costs, so high that the product could never be economically competitive, or technical problems, indicating the product would not be fit for its original purpose, in such situations appear secondary to the aim of continuing the project. In the nuclear waste industry there is a similar tendency that a process started must go on continuously. To stop a project to rethink and make radical changes is difficult, or even impossible. The economically most important reason for the industry is to provide a reassuring image that the nuclear waste management is developing according to plan to take care of the waste that is continuously produced by the power reactors.

Another economic aspect on these planning processes is that the cost of continued planning can be lower than the interest rate on the cost of actually doing something with the waste. Slowing down the process will then be economically profitable to the organisation responsible for the waste management costs.

There is a risk that mistakes will develop into failures, or in economic terms into great planning disasters.

4. Conclusions

This presentation is intended to stimulate a rethinking of the expensive projects motivated by the need to manage spent nuclear fuel. As individuals you may question your position in this business. As collective stakeholders you may look at the real long-term interests of the organisation – and long term in this case is long.

Most important is to assess the global long-term strategies available. It is complicated in the sense that other developments will have implications for spent fuel management, but that is not a good reason to avoid the strategic analysis. The common excuse for not thinking about the important issues, that "so much money has already been spent", is probably not a good argument. The difference in cost between a good long-term system and future costs of continuing bad systems is likely to be many times higher that the total money already spent.

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