

Estimations of costs for dismantling, decommissioning and associated waste management of nuclear facilities, and associated impact on decision processes, functioning of markets and the distribution of responsibilities between generations

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Abstract

The future dismantling, decommissioning and associated waste management of nuclear facilities constitute very substantial liabilities worldwide. Legislation and systems are in force in several countries to ensure that funds are available at the time when they are needed and that it is, according to the Polluters Pays Principle, the generations that benefit from the use of the nuclear facilities that also carry the financial burden.

This in turn constitutes a number of challenges which warrant proper attention, and which are dealt with in the present paper: how to carry the burden of financing, the need for securing the funds until the time when they are needed, and the need for precision in the cost calculations with regard to a number of factors. The latter includes the approach selected regarding fairness, in the allocation and distribution of the liabilities between generations, the requirements regarding the functioning of the system of finance (sufficient but not superfluous funding) and the quality warranted for the bases for various decisions needed (e.g. potential investment opportunities in new nuclear research reactors and/or nuclear power plant).

It is described how sufficiently precise cost calculations might be achieved using appropriate calculation methodologies in combination with radiological characterisation, technology selection and financial uncertainty analysis. Examples are given from authentic Nordic work on fuel cycle laboratory and pilot scale facilities.

Keywords: nuclear, decommissioning, decontamination, dismantling, radioactivity, liability, fund, cost calculation, estimate, environmental, legislation.



1 Preamble

It is expected that perhaps hundreds of nuclear power reactors and other major nuclear facilities will be closed during the next few decades and thereby be awaiting dismantling and decommissioning. Such a closed facility typically represents a large negative monetary value with a negative cash-flow – perhaps even comparable in magnitude to that of the initial investment. The main reason for this is the presence of residues of radionuclides, which may well cause the cost for decommissioning to be a couple of orders of magnitude higher than would otherwise be the case.

Historically, responsible action in this regard has varied considerably between different types of nuclear facilities and geographic regions. In many cases, it has been left to Governments to finance remedial actions. A typical environmental project has had to compete with numerous other ones for funding and the result has typically been too little action at a late stage when the problems have already escalated.

There is a growing awareness internationally that appropriate and responsible decommissioning as well as waste management and disposal are fully integral parts of the utilization of nuclear energy. Consequently it is necessary that methods and techniques be developed and applied such that any effects on environment and health are small.

Hence, effective technical tools exist of many kinds for safe and efficient dismantling and decommissioning of various nuclear facilities. However, financial tools are also needed such that sufficient but not superfluous funding is made available at the time when it is needed.

The issues of appropriate and prudent funding as well as estimations of the funding needed are closely interlinked with a number of technical issues, thus making the full analysis of this system complex and difficult. There is a growing awareness of this internationally, e.g. through activities by IAEA, OECD/NEA and EU/COM as well as by many workers in the area. Systems for financing are being established in different countries, and experience is being gained on how to achieve the goal of adequate funding at the appropriate time for efficient and safe decommissioning of the various kinds of nuclear facilities.

The establishment of systems of finance requires that the needs and prerequisites are identified and established, and that difficulties are dealt with, feasible approaches found and effective methodologies developed. It is the purpose of the present paper to provide some detail and examples in this regard. It is largely a result of recent work [1] financed by the Swedish Nuclear Power Inspectorate and also the Nordic Nuclear Safety Research.

2 Needs and prerequisites

The polluter pays principle. The principle that it is the polluter that pays is now relatively generally accepted and established. In concordance, the IFRS (International Financial Reporting Standards) and the IAS (International Accounting Standards) that apply to stock companies in many countries have



very strict rules on reliable and precise estimations of liabilities, and secure protection of the corresponding assets including monetary funds.

Identification of the polluter. The polluter is the one that is reaping the benefits of the operation of the facility in question. A corollary to this identification is that no burden should be placed on future generations, e.g. no encroachment should be allowed on the future consumption level due to any remedial actions, now or in the future.

The level of environmental quality after restoration. In theory, the liabilities should include dismantling and decommissioning of older nuclear power plants and other facilities as well as restoration of the land to initial conditions, i.e. *green field conditions*.

However, imposing such requirements within e.g. the EU area would undoubtedly be associated with considerable costs. Consequently, it has been discussed if *brown field conditions* might be acceptable. Such conditions would mean that some radioactive components, e.g. heavy structures, might be left indefinitely.

For the purpose of the present paper, the brown field conditions are discarded on grounds of it leaving responsibility of fairly easily accessible radioactive matter to future generations indefinitely, thus not complying with the polluter pays principle.

The link between the polluter and the restoration. It has also been discussed that nuclear site areas might be used for successive generations of nuclear facilities, and that green field conditions in this perspective might be required only at the end of a period of perhaps three to four nuclear generations. Such an approach might imply that there may be up to 100–150 years between the first reaping of benefits and the final decommissioning of the land.

In the application of the polluter pays principle, it is important that the link between the allocation of assets and the full cost for the restoration be sufficiently strong. Extending the time frame over several human generations raises a number of questions including the one of the stability of the society. Moreover, restoration after just one generation is feasible. Consequently, the approach of successive use is also discarded from further consideration in the present paper.

Need for harmonization of requirements. There has been a successful deregulation of the energy market within the EU. This deregulation presupposes that the environmental requirements are equal for all producers, distributors and consumers. Otherwise some energy companies might be tempted to apply minimum or even inadequate environmental standards in order to gain a competitive edge.

Proper priority to liabilities. Business news media report that the median occupation time for managerial positions in industry may be only a few years. Since the environmental liabilities for nuclear facilities extend over decades it would be naïve to assume anything but that long term financing of environmental liabilities are likely to receive a lower priority as compared to e.g. short-term or quarterly profits. This may regard the level of ambition as well as the efforts put into the estimation of future costs.

