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The problem of used nuclear fuel: lessons for interim solutions from a comparative cost analysis

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Abstract

An acceptable long-term solution for used (spent) fuel from nuclear power reactors has evaded all countries engaged in the civilian nuclear fuel cycle. Furthermore, many countries are trying to develop interim storage solutions that address the shortage of storage in the spent fuel cooling pools at reactors. The United States has a particularly acute problem due to its adherence to an open fuel cycle and its large number of reactors. Two main options are available to address the spent fuel problem: dry storage on-site at reactors and centralized storage at a facility away from reactors. Key to deciding which option makes better policy sense is the comparative economics of the two options. This paper provides one of the few comprehensive comparisons of costs for the two alternatives and discusses implications for other schemes and possible alternative solutions to the spent fuel problem for the United States.

Keywords: Spent fuel; Nuclear energy; Energy policy

1. Introduction

Forty years of nuclear power usage has produced no permanent solution to the management and disposal of back-end waste products. Even the short-term management of spent fuel from nuclear power reactors is debated: should it be stored on site or should it be stored at a centralized facility off-site? The United States may suffer more from this problem than other countries in that it has many more nuclear power plants than most other nations and thus more spent fuel, but it is not unique in having to deal with these problems. Japan, for instance, faces a storage space shortage at their reactors and as yet has no solution to the problem. Originally, they had planned to move spent fuel off site to a reprocessing plant — but that plant remains under construction while spent fuel builds up at local reactors. Thus, the problem of how to manage spent fuel in the interim, before a permanent solution is agreed upon, is an important issue for all countries that use nuclear power.

The spent fuel storage situation in the United States is becoming increasingly urgent, and it is possible that some reactors may even be forced to shut down if this issue is not resolved. US nuclear reactors have produced over 40,000 metric tons (MT) of spent nuclear fuel, which currently resides on-site at reactors. By the end of the existing 103 currently licensed, operating reactors' lifetimes, the total amount will likely be over 80,000 MT. Still more will be generated if reactor licenses are extended, as they are beginning to be now. None of these reactors has the capacity to store all the spent fuel they will produce over their lifetimes. To relieve the burden of spent fuel storage from cooling pools at individual nuclear reactors while they await the opening of a permanent repository, they will need some type of interim solution. One option is to store the spent fuel on site in dry casks, while an alternative option would be to create a centralized interim storage facility. The US Congress recently considered establishing a centralized storage facility near Yucca Mountain, Nevada, and at least two private facilities are under review for large-scale spent fuel storage. Spent fuel storage, therefore, will remain at the top of many agendas and as a result, it is important to understand the issues involved to make the best choices possible.

One of the main debates over the best way to resolve the spent fuel problem in the short term is over the comparative cost of the options. Those who support

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a centralized interim storage site contend that a centralized facility for spent fuel would minimize at-reactor storage and, as a result, significantly reduce costs (Kraft, 1999). On the other hand, the transportation of spent fuel from power reactors to another location would entail additional costs not included in at-reactor storage. Why should these costs be borne now, instead of waiting until a permanent repository is actually available, thereby discounting the transport costs? The benefits of consolidated storage, moreover, may take decades to achieve. To settle this debate, a comparative analysis is required. Unfortunately, to date, neither Congress nor the Energy Department have completed a current detailed analysis of the costs of the at-reactor and centralized facility options. To address the spent fuel storage issue, this paper will provide such a cost comparison.

To make effective spent fuel policy, policy-makers should be concerned with the question of whether centralized storage would be a cost-effective measure. Other questions, such as whether centralized storage of spent fuel is politically and technically feasible are arguably as important as the economic one, but they have been dealt with in other publications (see Macfarlane, 2001). Although the case presented in this paper specifically addresses the situation in the United States, this analysis will provide a template discussion that is applicable to the situations in other countries.

The record has shown that nuclear waste issues, especially those in the United States, do not particularly lend themselves to easy solutions. For instance, currently there are no permanent operating repositories in the United States for the nation's low- or high-level wastes.[1] Costs for the interim storage of spent fuel will run into the billions of dollars. The significance of this issue can be measured by the level of frustration that already exists in the US Congress over the costs of developing a permanent nuclear waste repository at Yucca Mountain, Nevada. To avoid wasting huge sums of the taxpayers' money, it is necessary to have a good understanding of the costs involved in the interim storage of spent fuel before proceeding with any particular policy recommendation. The discussion in this paper should clarify the costs to be paid and will suggest alternative solutions to the spent fuel problem.

2. Policy background

Many utility companies that own nuclear reactors expected that the spent fuel problem would be resolved by now because US law stipulated that the Department of Energy (DOE) would begin to move it by 1998. The Nuclear Waste Policy Act (NWPA) of 1982 established that spent fuel and other high-level radioactive waste would be disposed of in a geologic repository. It also set the date to begin the transportation of spent fuel from reactors as January 31, 1998. Even though amendments to the NWPA designated a location for a repository in 1987 (Yucca Mountain, Nevada, was selected), by the early 1990 s, it was clear that such a facility, if licensed, would not be able to accept spent fuel until at least 2010. By corollary, then, it was clear that utilities would have to find some way to accommodate the spent fuel on their own.

Interim storage of spent fuel is not a new concept in US policy. The Nuclear Waste Policy Act allowed the construction of a centralized interim storage facility for spent fuel. To ensure fairness in storing and permanently disposing of nuclear waste, the NWPA prohibited the siting of a centralized storage facility in any state under consideration as a permanent repository site. The 1987 Nuclear Waste Policy Act Amendments (NWPAA) alleviated concerns that a centralized storage facility would become a defacto permanent repository by the provision that construction of a centralized facility could only occur after the license for a permanent repository was granted (Gerrard, 1994). Again, as with the NWPA, the NWPAA distinctly forbade the construction of a centralized storage facility in the state of Nevada, the designated location for a permanent repository.

A Monitored Retrievable Storage Commission, established by the NWPAA, determined that some type of interim storage would be needed, but not a large volume facility (Monitored Retrievable Storage Commission, 1989). The Commission noted that the net cost of the centralized storage facility option might be less than no centralized facility, but that the centralized storage facility option would be more costly on a discounted basis. They noted that a centralized storage facility, linked to the licensing of the permanent repository as it was in the NWPAA, would not address storage issues. The MRS Commission recommended that Congress authorize a federal emergency storage facility licensed to hold 2000 MTU of spent fuel and a utility-funded facility licensed to contain 5000 MTU (Monitored Retrievable Storage Commission, 1989), though none was ever constructed.

When it became clear to the nuclear utilities that DOE would not meet the 1998 deadline by which it was to accept their spent fuel, they began to address the problem themselves by lobbying for legislation to establish a centralized interim storage facility at Yucca Mountain and by entering into negotiations with Indian tribes and other localities to develop privately managed interim storage facilities. Three of these private storage options have received considerable attention, two on tribal lands,

[1] The Waste Isolation Pilot Project was finally allowed to receive defense complex transuranic waste years behind schedule. Furthermore, the few existing low-level sites (Barnwell, South Carolina, for example) take waste only from a limited number of states. Most states have no permanent repository for low-level waste.