Decommissioning of Nuclear Power Plants and Storage of Nuclear Waste in Western Europe and the US - Lessons Learned and Perspectives for Asian Nuclear Countries

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Overview

The decommissioning of nuclear power plants (NPP) and the long-term storage of nuclear waste are major challenges to energy policy. Western Europe and the U.S., where a high number of reactors have reached the end of their lifetime, are already confronted with the organisation of the decommissioning process and the subsequent management of nuclear wastes. But also, Asian nuclear countries have to face these challenges in the coming years. The decommissioning process is technologically challenging and the world-wide ongoing search for storage sites is a long and challenging process. The financing is complex, it is not always clear whether the operator or the government is in charge. Additionally, the relationship between the oligopolistic nuclear industry with only a few suppliers for special nuclear services and the national regulators is characterized by an asymmetric information distribution between the two parties, a classical principal-agent problem.

This paper analyses and compares different strategies of organising the process of decommissioning NPPs, and storing the nuclear waste. The paper is based on a recent research project by the authors in the case of four major nuclear countries (Wealer, Seidel and von Hirschhausen, 2017), and in-depth case studies on the technical, economic, and institutional developments for these countries.

Methods

We deploy a comparative institutional approach to describe the strategic choices of plant operators and national and international governmental bodies, the "regulators". In a first step, we distinguish the two main elements of the strategy: the process needs to be financed, and someone has to manage the production process of the decommissioning and the storage.

Financing \ Production	A) Public enterprise	B) Public tender (centralized or decentralized)	C) Further alternatives	D) Private enterprise (decentral or status quo)
1) Public budget				
2) Unitary public funds				
3) Separate Funds				
4) Further alternatives				
5) Decentral provisions (status quo)				

Figure 1: Options for organizing decommissioning of nuclear power plants and storing nuclear waste – A matrix of financing and production

We have developed a detailed scheme of analysis (Wealer, et al., 2015), that will be specified in the paper. Figure 1 shows the essence of the matrix, that provides for different "organizational models" for the sector: the y-axis specifies different ways of financing the process, such as the federal budget, a dedicated fund (private or public), in-house financing by the companies, and yet others. The x-axis shows different actors that could carry out the decommissioning and the storing. These actors can be private or public companies, generally regulated under incentive- or cost-plus regulation.

The empirical part of the paper includes four case studies, that have been developed by the authors for four countries with a strong nuclear sector: the U.S., Germany, the U.K., and France. The case study on Germany includes results from a research project on the German nuclear policy (Kemfert, von Hirschhausen, et al., 2015), the other ones are based on in-depth desk research, but on-site case studies are planned. Based on the findings and expe-

riences, the current decommissioning and waste management policies of China, India, the Republic of Korea and Japan will be analysed and perspectives and lessons-learned will be drawn.

Preliminary Results

The financing of both processes is a long-term challenge and cost estimations are underlying uncertainties due to the long time-scales, and estimated interest and inflation rates. This could lead to an underestimation of future costs. In Germany, the financing and liability system was reformed in 2016 and the liabilities for the storage were transferred to a public fund. In the UK, the lessons learned from the shortfall of former provisions for the older Magnox fleet led to the establishment of a public fund for the operational fleet. In France, the financial resources are secured in internal segregated funds with a strict administrative control and oversight by national authorities, but there are concerns that costs are underestimated.

The production of both processes is technologically challenging and both processes were in most cases neglected, hence decommissioning experiences are scarce and a high level waste disposal facility is still missing. While the siting and future operation of such a facility is the scope of a public company, the decommissioning of the power plants - except for the British and German legacy fleets - is more or less done by private companies. Overall, it can be concluded that both processes are highly interconnected and need an integrated planning approach, e.g. missing waste disposal routes hinder the decommissioning process and interim storage facilities had to be build.

In Asian nuclear countries, where – with the exception of Japan – the decommissioning and the waste management are not yet as pressing, policy perspectives and lessons learned could be derived from the encountered experiences in the observed countries, for example transparent detailed decommissioning cost studies, an integrated planning approach for the decommissioning and waste management, and a well-established public fund for both processes.

Conclusion

Decommissioning of NPPs as well as the search for a final storage site are complex challenges. This paper identifies lessons from the specific national approaches of Western Europe and the US to decommissioning and storage, in particular at the interaction between financing, service provision and regulation and derives policy perspectives and lessons learned for Asian nuclear countries.

In general, the approach with a public fund seems to be the most suitable to finance the future costs, to adhere to the "polluter-pays principle", and to mitigate the financial risks of the society even if it also could not overcome the problem of too low cost estimations. The payments to the fund should be spread over time in order to help the companies to adapt. The interdependencies between financing and production are too strong to be treated separately, therefore a joint approach for both will probably be the most efficient solution for the wicked problems of nuclear phase-out.

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