

Decommissioning of Nuclear Power Plants Worldwide - Status Quo, Lessons Learned and Policy Perspectives

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Overview

Nuclear power is a major research field in engineering, but not in economic policy neither in industrial organization; especially decommissioning of nuclear power plants (NPPs) has been sparsely addressed so far. Only a few NPPs have been decommissioned so far, but hundreds of plants are globally preparing to be decommissioned in the coming decades. Given this expected massive shutdown of plants and the estimated \$1,000 billion USD value of the decommissioning market until 2050 (IAEA, 2004), there is an urgent need for a better understanding of the decommissioning process, as well as decommissioning policy, regulations, and markets.

This paper analyses and compares the different national decommissioning policies and practices in all the countries that have already shut down NPPs (Figure 1). The paper is based on recent research projects by the authors in the case for the major nuclear countries of France, Germany, United Kingdom, Sweden, Switzerland, the United States, Korea, and Japan (Wealer et al., 2015; Seidel, Wealer, 2016; Wealer, Bauer, et al., 2017; Wealer, Czempinski, et al., 2017), and in-depth case studies on the technical, economic, and institutional developments for these countries.

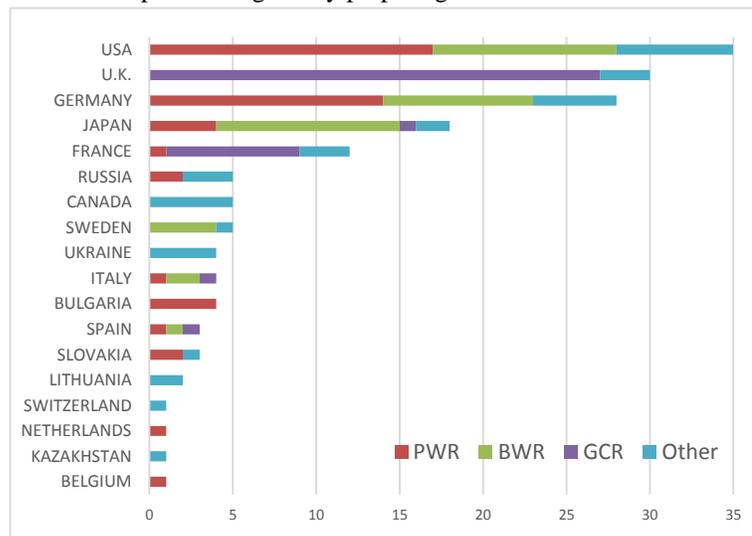


Figure 1: Shut down nuclear power plants worldwide, (IAEA, 2017).

Methods

We deploy a comparative institutional approach to describe the strategic choices of plant operators and national and international governmental bodies, the “regulators”. We distinguish the two main elements of the process: decommissioning needs to be financed, and someone has to manage the production process of decommissioning. The case studies are based on a detailed scheme of analysis (Seidel, Wealer, 2016), that provides for different “organizational models” for the sector: on the one hand different ways of financing, such as the federal budget, a dedicated fund (private or public), in-house financing by the companies, and yet others; and on the other hand the different actors carrying out the decommissioning process, which can be private or public companies, generally regulated under incentive- or cost-plus regulation. The empirical part of the paper includes case studies, that have been developed by the authors for the above-mentioned countries. In addition, the remaining countries (See Figure 1) will be included in the analysis. The statistical analysis will focus on the technological status quo of the global decommissioning process, cost estimates and realized costs, but also the market structure will be analysed. The case studies are based on in-depth desk research, but on-site case studies are planned.

Preliminary Results

Most plants currently in the or entering decommissioning were built during a period, where the idea of decommissioning was not yet fully conceptualized resulting in countries having to use trial-and-error methods. In addition, countries are also struggling with financial shortfalls in decommissioning funding. These shortfalls, early shut-downs, and rising costs are forcing some plants to delay decommissioning in order to build up additional funds. As a result, countries are also considering ways to enable facilities to recuperate their costs through higher fees, subsidized prices, or longer operation times (Album et al., 2017). Financing of the decommissioning processes is a long-term challenge and cost estimations are underlying many uncertainties (e.g., long time-scales, estimated interest and inflation rates) and are hence prone to underestimation. France, for example, has one of the lowest cost estimates but one of the largest nuclear fleets (See Table 1). In a recent survey, the National Assembly (2017, own translation) concluded that it cannot share EDF's overly optimistic view on decommissioning, which is going to be much more expensive and technologically challenging than estimated.

In some countries, procurement laws have been put in place to create a competitive market. However, as the decommissioning market has been evolving, challenges to the competitive ideal have arisen: market concentration and asymmetries of information. This oligopolistic structure combined with the increase in demand for decommissioning

services gives rise to concerns regarding the functionality of the market. There has been a lot of innovation in financial products too: common decommissioning funding and third party financing of funds. In the more competitive market setting of the U.S., third parties are also showing interest in financing decommissioning funds. In each case, how financial shortfalls will be resolved should the decommissioning funds prove to be insufficient remains to be seen.

| Country | Op. NPPs [inst. Cap.] | Shutdown NPPs [decommissioned] | Av. duration | Realized Costs | Future cost estimation |
|---------|-----------------------|--------------------------------|--------------|----------------------------|------------------------|
| Germany | 8 [10.8 GW] | 28 [3] | ~19 years | 1,400€/kW... 10,000€/kW | 1,250 €/kW |
| France | 58 [63.2 GW] | 12 [0] | - | 1,130€/kW (PWR) | 380 €/kW |
| U.K. | 15 [8.9 GW] | 30 [0] | | | 2,700 €/kW |
| Japan | 5 [51.4 GW] | 18 [1] | ~10 years | 1,900€/kW (JPDR) | 980 €/kW |
| USA | 99 [99.9 GW] | 35 [13] | ~10 years | 280€/kW... 1,500€/kW | 600 €/kW |

Table 1: Decommissioning experiences in selected countries.

Conclusion

Decommissioning of nuclear power plants poses a complex challenge to utilities and regulators. This paper identifies lessons from the specific national approaches on a global level; in particular at the interaction between financing, service provision and regulation and derives lessons learned and policy perspectives for nuclear countries. In general, decommissioning has been underestimated from a financial as well as a technological point of view. This had led to poor outcomes, where decommissioning projects are already being executed. From a financing point of view, a public fund seems to be the most suitable option to finance the future costs 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.

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