

The Application of a New Institutional Economics Framework to the Process of Decommissioning of Nuclear Power Plants – Determination of Best Practice Approaches from France, Germany and UK

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Overview

Nuclear power plants (NPP) have an licensed lifetime, increasing the need for research on decommissioning (Kim et al. 2019). Worldwide, there are currently 415 nuclear reactors online with a mean age of 30.09 years and 196 shut down reactors with a mean age of 27 years (Schneider et al. 2021, 59–61). Power generation from NPPs brings with it substantial responsibilities: once the lifetime of an NPP ends, it must be decommissioned properly and radioactive waste must be processed and stored safely. Decommissioning of NPPs is a complex, highly individual process in terms of coordination between stakeholders, governmental institutions and financing (Hirose and McCauley 2022; Wealer, Seidel, and von Hirschhausen 2019). Countries currently in this process follow different approaches, mainly due to historical owner-operator structures, e.g. German NPPs are mostly operated by four major utilities, while in France, *Electricité de France* (EDF) is responsible for most reactors. In the UK, the *Nuclear Decommissioning Authority* is responsible for the process of decommissioning (Foster et al. 2021; Hirose and McCauley 2022). Currently, there is no clear indication as to which approach is the most effective and transferable approach. Policy design, especially the definition of competences amongst different governmental agencies, can have an impact on the effectiveness of this so far individually designed process (Hirose and McCauley 2022). This process relies on functioning interrelations between institutions, firms and individuals. To holistically describe this process, we thus apply the theory of New Institutional Economics to NPP decommissioning. Hereby, we attempt at defining best practice approaches on Levels 2 and 3 of Fig. 1, as these levels are most influenced by policy (Williamson 1998). By this, we are able to offer insight for policy makers in countries still having to or are currently in the process of defining their respective policy approach for NPP decommissioning.

Methods

Decommissioning of NPPs is a long-term multi-disciplinary task, including both technological and organizational elements (Laraia 2018). It must be conducted in a safe manner to ensure no radioactive waste escapes and it must be conducted in a way that is least burdensome to future generations (Laraia 2018). To achieve this, governments must make policy strategy decisions to guarantee the process will continue in the centuries to come. We apply this to the framework introduced by Williamson (1998) to, in a first step, determine a holistic description of the decommissioning procedure and the minimum requirements in terms of involved institutions. We then apply the framework to current decommissioning policies in France, Germany and the UK to determine best practice approaches in terms of efficiency, cost and fulfilment of pre-defined objectives.

Results

The first level of Fig. 1 describes informal institutions and customs. Here, we define this level as the attitude of the public towards to nuclear power generation. This attitude can change over time, e.g. the swift policy change in Germany after the Fukushima disaster in 2011, which ultimately resulted in the nuclear phase-out experienced today. While Level 2 sets the formal rules, i.e. the law and oversight, Level 3 describes the concrete interactions between actors, i.e. governmental agencies and their contractors, as was briefly observed in the UK. Finally, Level 4 defines concrete actions and resource, i.e. monetary, allocations. When regarding the different approaches in the observed countries, differences become evident: Germany that, with the UK, currently has one of the largest fleets of shutdown nuclear reactors, has chosen a more complex approach in terms of policy regulation as the UK or France have: in Germany several agencies are directly involved in monitoring the progress of decommissioning and several ministries are then tasked with overseeing the whole process. In comparison, the UK, after having failed in implementing a semi-privatized approach, relies fully on the Nuclear Decommissioning Authority to complete the task. France has chosen a middle stance and has only two agencies involved. Similar differences apply to the responsibilities of NPP operators. In all three countries, decommissioning processes have been delayed and costs have been underestimated (Wealer, Seidel, and von Hirschhausen 2019; Schneider et al. 2021). By applying our model, we find that the optimal policy approach is highly dependent on the initial situation in the respective country. An independent optimal strategy could

not be determined. However, by applying the well-established framework, we are able to offer a model for policy makers in countries that are still facing the implementation of decommissioning policies.

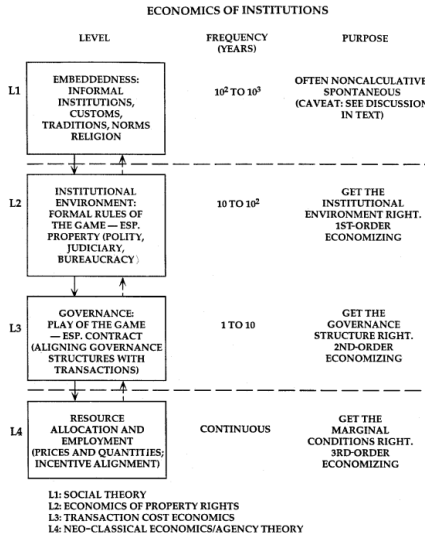


Fig. 1: Four levels of institutional economics, taken from Williamson (1998)

Conclusions

Decommissioning of NPPs is a long-term mission for countries that have historically relied - and in some cases still are - on nuclear power generation (Laraia 2018). Now, as NPP fleets age and plants are frequently shut down, the process of decommissioning becomes increasingly important (Kim et al. 2019). Only few countries have been so far able to gather experience in this field and various approaches are chosen. We must also note, that no country has so far fully completed the decommissioning process by also permanently storing highly radioactive nuclear waste (Wealer and Hirschhausen 2020). This paper attempted to apply theory from New Institutional Economics to the complex process of decommissioning of NPPs to aide policy makers in the definition of a transparent, financially sound, safe and secure as well as efficient strategy. By giving examples of three different approaches in France, Germany and the UK, we showed advantages and disadvantages of the chosen strategies in Europe.

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