# To commit or not to commit: the social cost of political uncertainty in French nuclear policy

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## (1) Overview

Nuclear power is a key carbon-free technology but plant operators and investors in the field are facing challenges that hamper the deployment of this technology, particularly in OECD countries. Such challenges range from decreasing wholesale prices for electricity to political uncertainty and public resentments towards the technology. These challenges jeopardize the returns of nuclear power plants needed to cover its high fixed (investment) costs and could ultimately lead to a phase-out from the technology, either on political or economic grounds, in some countries. The demand for fixed feed-in tariffs for nuclear power plants in Great Britain is just one example for an attempt to cope with these challenges.
The Fukushima/Daiichi catastrophe led to rising political uncertainty for nuclear power operators and a partially changing public perception of the technology: it resulted in nuclear power plant moratoriums in Germany and Japan, the rethinking of nuclear power as a safe source of electricity in most countries operating nuclear power plants and in the ultimate nuclear phase-out decision in Germany and Switzerland. Even in historically nuclear friendly Japan, a nuclear phase-out is being considered.
However, a stable political framework is of particular importance for nuclear power plant investment, considering the high investment costs and the long term nature of such projects. High risk and uncertainty ultimately lead to increased capital costs for nuclear power plant investors.
France is with regard to nuclear power of particular interest for two more reasons:

- Its historically high share of nuclear power in electricity generation: Nuclear power contributes about 70-80% to electricity generation in France; the highest share of nuclear power in electricity generation in the world.
- The age structure of its nuclear power plant fleet: Most French nuclear power plants have been built in the time period 1975 to 1985 under the Messmer Plan. Thus most of these plants are facing prolongation decisions or are likely to be shut down in the period 2025 to 2035 which is more pressing than one might think given recent experience in nuclear construction time ranging between 5 and 10 years in Europe.

Our analysis therefore focuses on the possible future role of nuclear power in France. It highlights in particular two aspects:

- The feasibility and costs of a phase-out from nuclear power in France under varying phase-out regimes.
- The effect of political uncertainty towards future French nuclear power policy on investment decisions in the power system and the arising costs.

## (2) Methods

We investigate these aspects using a stochastic linear programming model of the European power system. Given certain input parameters and constraints, the model calculates dispatch and investment decisions in such a way that residual electricity demand is satisfied and total expected discounted system costs are minimized.[1] Main input parameters are demand development, fossil fuel and $CO_2$ prices, the development of renewables generation as well as assumptions concerning future technology availability (see Fürsch et al. (2012) for a detailed description of the deterministic version of the model). The timeframe of our analysis extends to 2050 in five-year steps.
Uncertainty enters the model in the form of whether or not there is a nuclear phase-out decision at a particular point in time. We compute sensitivities on the form of the decision, i.e. whether the phase-out takes place immediately after the phase-out decision or over an extended period of 15 years, on the probability of the occurrence of a phase-out decision, and on the possibility of prolongation of existing nuclear power plants.
To our knowledge the stochastic programming framework has not been applied in this context before. Previous applications of the approach in energy market analysis has mainly focused on uncertainty towards demand (see e.g. Gardner (1996), Gardner and Rogers (1999)), towards fuel prices and $CO_2$ prices/regimes (see e.g. Roques et al. (2006), Patino-Echeverri et al. (2009)) or uncertainty towards renewables feed-in (see e.g. Nagl et al. (2012) and the literature overview therein).

[1] Residual demand refers to the demand met by conventional generation, and is essentially given by total demand minus generation from renewables (RES-E). RES-E generation is treated exogenously in our analysis and is not optimized over time within the model.

## (3) Results

Our analysis shows:

- The French power system can adapt to a phase-out from nuclear power although at the expense of increasing system costs in France, increasing wholesale prices for electricity (increases up to 100%) and increasing $CO_2$ emissions. [2]
- The additional costs in France of a phase-out can be significant, ranging up to 80 billion € in a scenario with an immediate nuclear phase-out in 2020 as compared to a scenario without nuclear phase-out and the possibility of prolongation of existing nuclear plants.
- Additional total system costs of a French nuclear phase-out are taken to a large extent by the French power system and are only passed onto the rest of the power system by a small fraction.
- The costs of uncertainty, although rather limited in most scenarios, can amount up to 15 billion € in a setting with a high probability of a phase-out and no-prolongation possibility for existing nuclear power plants.
- Costs of uncertainty are typically lower in scenarios with an extended phase-out period of 15 years than in those with an immediate phase-out from nuclear power.
- In the short run, we observe less investment in the short run in new nuclear power capacity under uncertainty. On the other hand we typically observe that more existing nuclear power plant lifetimes are prolonged under uncertainty. The relatively lower investment in new nuclear power plant capacity in the short run leads to catch-up effects in the longer run.

## (4) Conclusions

A nuclear phase-out is possible even for a country like France but it comes at a high cost burden for society. Bearing in mind that most heating in France is still electricity based, rising wholesale prices for electricity are of particular political and social relevance. The observation that costs of uncertainty are typically lower in scenarios with an extended phase-out period bears implications for policy makers. A credible commitment against immediate nuclear phase-outs leads to significantly lower costs of uncertainty and hence to lower costs in case of a phase-out. The examples of Belgium and Switzerland are in line with this observation as these countries have opted for extended phase-out periods. In addition, our analysis suggests that Japanese decision makers are advised to commit to a decision and create an environment of political certainty to keep the social costs low. Further research in this area could for instance focus more strongly on safety aspects of nuclear power plant operation which has not been incorporated within our analysis.

## References


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[2] Costs refer to discounted costs for the whole power system respectively for the French power system accumulated over the time horizon until 2050. A discount rate of 10% has been assumed.