Quantifying the Cost of Uncertainty on the Belgian Nuclear-Phase-Out

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Overview

In Belgium, starting from 2015 until 2025, nuclear power plants with a total capacity of 5.9 GW are scheduled to be phased-out. These power plants represent a substantial share of about 41 % of today's total available capacity (End 2016: 14.1 GW according to the ENTSO-E transparency database). In a recent adequacy study for the years 2030 and 2040, the Belgian transmission system operator raises the issue of investment needed to replace missing capacity by 2025. At the same time, voices from politics and industry reopen the discussion on the extension of the lifetime of the nuclear units. However, the resulting mismatch between security of supply and policy uncertainty about a phase-out reduces the confidence of investors.

Methods

The electricity market is characterized by multiple actors, which interact with one another in different ways through regulation, policies and the market. Each market participant has its own specific objectives, can make certain decisions, faces boundary conditions, and derives expectations towards the future. A stochastic equilibrium model, which is capable of representing the interactions between policies, markets and agents, is proposed. It is used for generating long-term descriptive scenarios. The dynamic equilibrium model, including periodic investment decisions of different technologies over the time horizon of 10-30 years, allows applying a game-theoretic approach to evaluate transition pathways. Uncertainty about the policy-decisions including the lifetime extension of existing nuclear power plants, i.e., postponing the energy transition, is modelled in form of scenarios.

Results

The developed model is applied to a realistic test system representing the Belgian power system in an interconnected context. Focus is put on quantifying the cost of uncertainty stemming from a possible lifetime extension of existing nuclear power plants and comparing them to other inherent uncertainties such as fuel prices or availability of RES. Multiple possible developments as well as assumptions about the investors' reaction to the policy uncertainty are benchmarked with a test case where the nuclear phase-out follows the predeternined schedule. This is done using indicators like the total system cost, point in time and extent of investment in alternative technologies, but also operational details such as resulting Expected Energy Not Served. Moreover, the effect on risk-averse agents facing decisions about capital-intensive investments with a long life time is highlighted.

Conclusions

The impact of a substantial change in the generation mix in a system, such as one triggered by a nuclear phase-out, needs to be unambiguously addressed. Uncertainty about re-scheduling leads to inefficient decision-making of market participants e.g. resulting in a cost increase for consumers. This cost increase originates from deferred necessary investments and potential shortages in the market, eventually materializing in the need for involuntary load shedding. Even small uncertainties in combination with risk-averse behaviour result in a cost increase that exceeds the impact related to uncertainties about market or fuel prices. As such, the findings indicate that far-reaching policy-decisions must avoid additional uncertainty is avoided and communicated in a convincing way.

References

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