CAN WE PHASE-OUT ALL OF THEM?
HOW MARKET INTERVENTIONS IMPACT SECURITY OF ELECTRICITY SUPPLY IN GERMANY

Lars Nolting,
RWTH Aachen University,
Institute for Future Energy Consumer Needs and Behavior (FCN),
+49 241 80 49901, LNolting@eonerc.rwth-aachen.de

Aaron Praktiknjo,
RWTH Aachen University,
Institute for Future Energy Consumer Needs and Behavior (FCN),
+49 241 80 49691, APraktiknjo@eonerc.rwth-aachen.de

Overview

In wake of the Fukushima Daiichi nuclear disaster, the German government has decided to gradually phase-out nuclear power plants until 2023 (German government, 2011). In turn, reduced nuclear power plant capacities were partly replaced by ramping-up coal-fired power stations (Morris and Pehnt, 2016). However, this situation has negatively affected Germany's carbon footprint. In order to reach the self-imposed climate goals nevertheless, an additional policy-driven phase-out of coal-fired power plants is currently about to be implemented. The general terms of the decommissioning of coal-fired power plants, which have been suggested by the so-called "*commission for growth, structural change, and employment*" (German governmental parties, 2018), foresee a reduction of marketable coal-fired power plant capacities by 2022 to ~15 GW lignite (from ~20 GW in the end of 2018) and ~15 GW hard coal (from ~23 GW in the end of 2018). For the according decommissioning path of controllable power plants during the next years, please see Figure 1. Further capacity reductions are intended until 2030 and an end to coal-fired power generation in Germany is defined for 2038 at latest by the commission.[1]

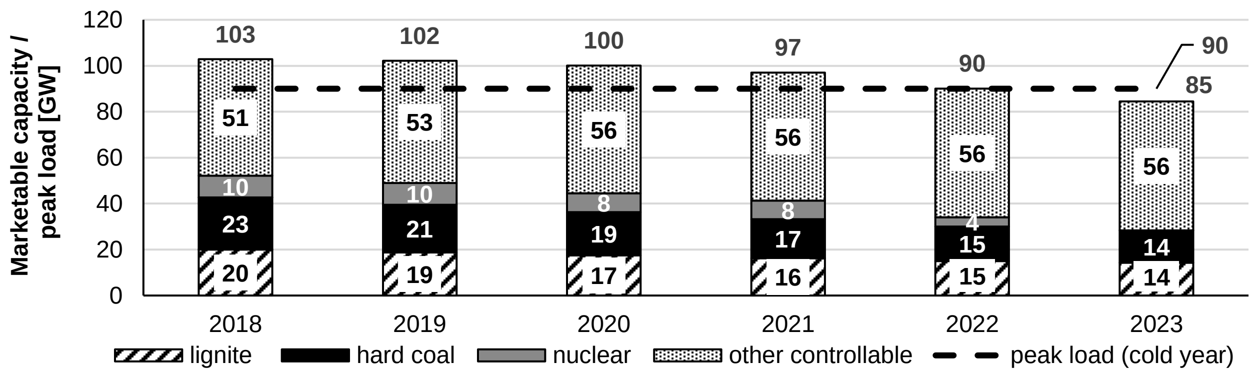

Figure 1: Marketable capacities of controllable power plants and peak load in Germany, unavailable capacities not yet accounted for[2]

Against the backdrop of these ongoing market interventions in addition to subsidizing intermittent renewables, the topic of security of electricity supply is gaining momentum in current debates. Concerns are raised that the policy-driven and non-competitive phase-out of both, nuclear and coal-fired power plants, might lead to situations, in which demand exceeds available production capacities. With these developments, demand for sound scientific methods and assessments of security of electricity supply rises.

Thus, our main research goal within the full-length manuscript is to investigate possible consequences of non-competitive interventions in the electricity market as shown above: we (1) assess their impacts on security of supply and (2) analyze, to what extend market mechanisms are capable of healing negative consequences by creating incentives for investments in additional capacities. For our analysis, we define different scenarios of reducing coal-fired power plant capacities that reflect possible outcomes of ongoing political debates as it is not yet defined, which share of coal-fired power plants is to be shut-down completely and which share is to be transferred to a so-called

[1] For further details regarding the proposed decommissioning path, please refer to (Commission for growth, structural change and empoyment, 2019).
[2] Sources of data: (BNetzA, 2018a; Commission for growth, structural change and empoyment, 2019; German government, 2011; BNetzA, 2018b).

"*capacity reserve*" to support security of supply. For each the reduction scenarios, we evaluate impacts on security of supply for 2020, 2022, and 2023, i.e. the medium-term perspective.

Methods

In this context, we developed a probabilistic assessment tool for security of supply as a module of the *JERICHO* energy system model from *RWTH Aachen University*. This model, which we present in further detail in the full-length manuscript, incorporates stochastic fluctuations of both, renewable feed-in and electricity demand, as well as dynamic (non-)availabilities of conventional power plants. In order to reflect the stochastic nature of weather influences, we conduct hourly simulations for 30 different weather years (1986-2015). This enables us to conduct scientifically sound assessments of security of power supply for different future scenarios.

Additionally, we conduct an economic analysis investigating whether scarcity prices during times with capacity shortages create sufficient market-based incentives for investments in gas-fired power plants and storage systems to fill possible capacity gaps. We thereby analyze if market competition will lead to an efficient market outcome.

Results

Based on our model outputs, we derive key indicators for security of supply such as the so-called *Loss of Load Probability* (*LoLP*), *Loss of Load Expectation* (*LoLE*), and *Expected Energy not Served* (*EEnS*). We believe that these indicators are an essential foundation for discussions related to security of supply, the phase-out of fossil power plants, and the question as to what extent renewables are able to fill this gap.

Our first results suggest that the historically *quasi-absolute* levels of security of electricity supply in Germany are untenable in medium-term future scenarios with high reductions of installed capacities. Additionally, our results indicate an increasing dependency of security of supply on weather effects, when the burden to cover electric load is shifted to intermittent renewable energies. Finally, our model outputs show significant sensitivity towards changes of available import capacities. Therefore, the German level of security of supply progressively depends on policy decisions of neighboring countries.

Regarding the economic analysis, our results indicate that the historically *quasi-absolute* levels of security of supply are not efficient from a welfare-point of view. Thus, we can conclude that security of electricity supply should not only be geared to technical needs, but should rather focus on economic needs. We provide a more detailed overview on our modeling results and economic interpretations in the full-length article.

Conclusions

We assess possible consequences of policy-driven and non-competitive market interventions. Our findings rest on the probabilistic *JERICHO* energy system model and imply that the historically *quasi-absolute* levels of security of electricity supply are likely to be untenable by planned mothballing activities. Regarding policy implications, we draw the following conclusions:

- It is *a priori* difficult to predict all consequences of market interventions in complex energy systems
- Thus, policy-makers should consider using primarily market-based instruments such as CO_2-certificates or taxes to regulate the system towards sustainable electricity supply and instead of perusing planned economy approaches.
- Further, the need arises to incentivize short-term investments in additional power plant and storage capacities in Germany to avoid inefficiently frequent load-shedding measures.
- To create a reliable environment and to ensure planning security for potential investors, the long-sighted definition of reliable political planning paths is necessary.
- Finally, our results call for an increased international coordination of national energy policies, as the level of security of supply in one country can seriously be affected by policy decisions of neighboring countries.

References

BNetzA, 2018a. Kraftwerksliste (Power plant list). Available at: https://goo.gl/L5zqPK [Accessed: 10 September 2018].

BNetzA, 2018b. Kraftwerksliste zum erwarteten Zu- und Rückbau (Power plant list on expected expansions and decommissions). Available at: https://goo.gl/VZSTS1 [Accessed:12 March 2019].

Commission for growth, structural change and empoyment, 2019, *Abschlussbericht (Final report)* [Online]. Available at: https://goo.gl/CpWehT [Accessed: 6 February 2019].

German government, 2011, *Dreizehntes Gesetz zur Änderung des Atomgesetzes (Thirteenth Law amending the Atomic Energy Act)* [Online]. Available at: https://goo.gl/56bz6P [Accessed:12 March 2019].

German governmental parties, 2018. Koalitionsvertrag (Coalation Pact). Available at: https://goo.gl/M8BDvw [Accessed:12 March 2019].

Morris, C. and Pehnt, M., 2016. Energy Transition - The German Energiewende. Available at: https://goo.gl/4z9MU4 [Accessed: 6 September 2018].