Optimal level of supply security in the power sector with growing shares of fluctuating renewable energy

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Overview

In modern societies, energy supply security is an essential factor for economic growth. However, the provision of supply security is also associated with cost. In a welfare maximizing society, the optimal level of supply security is given if the marginal cost is equal to the marginal benefit. We first evaluate the level of supply security using a probabilistic approach for a year taking conventional as well as unconventional generation technologies into account. Using these insights as well as recent estimates on the value of lost load, we deduce and discuss the welfare optimal level of supply security.

Methods

We develop probabilistic models to assess the level of supply security for

- the availability of individual conventional generators using a recursive convolution and
- the feed-ins of a given population for renewable power plants using a sliding window technique.

Both probabilistic models are then combined into a single probabilistic model using a Monte Carlo simulation.

Using the model's results as well as as the newest estimates for the so-called value of lost load, we deduce the optimal level of supply security.

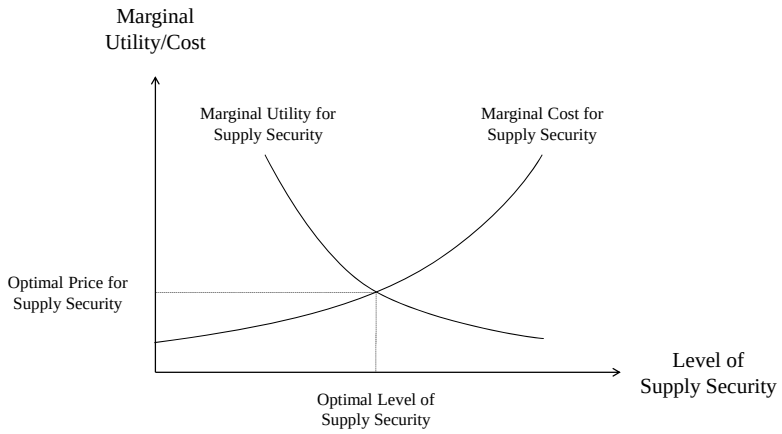

Figure 1: Welfare optimal level of supply security

Results

As a result of the model, we receive a characteristic curve for the secured available generation capacity in dependence of the chosen level for supply security for each hour of the year.

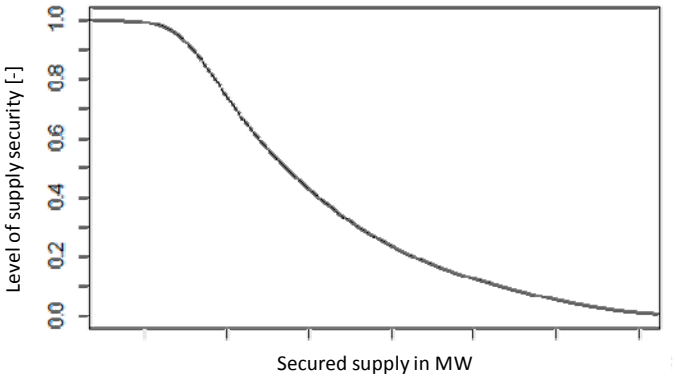

Figure 2: Secured available generation capacity in dependence of supply security level

As a result of the model, we obtain the contribution to secured supply for the different technologies including fluctuating renewable power generation. In the case of Germany, our results indicate that wind power onyly contributes to the peak load with approximately seven percent of its installed generation capacity.

Furthermore, using recent estimates for the so-called value of lost load, we estimate the optimal tolerable loss of load duration. In the case of Germany, this equals about half an hour within a year.

Conclusions

The results of the model allow an orientation for a welfare optimal level of supply security. Such estimations are particularly helpful when discussing secured supply in times of increasing shares of renewable power generation and policy mechanisms to ensure security of supply.

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