ECONOMIC AND OPERATIONAL ASSESSMENT OF ESTABLISHED AND NEW RESERVE METHODS AND METRICS FOR ELECTRIC GRIDS WITH HIGH SHARES OF RENEWABLES

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Overview

Operating reserves are a critical element to maintain the stability and reliability of existing electricity markets. These reserves provide a range of services including an immediate response to unexpected incidents, responsive power to restore nominal system frequency, and balancing power to compensate for uncertain conditions. The large-scale integration of renewable energy sources (RES) is an additional challenge that could impact the amount of reserves a system needs to have in order to ensure its reliable operation.

Methods

The goal of our study is to compare the costs and performance of various methods used to quantify reserve requirements and develop suggestions for optimal new methods that also account for the integration of RES. In a first step, a number of methodologies for quantifying reserves are identified and detailed, along with existing and proposed new metrics, and then assessed by quantifying their economic and operational performance. The evaluation of these metrics includes statistical methods, network analysis, and economic dispatch optimization. In a second step, the existing methodologies are tested under current and higher shares of RES scenarios in order to quantify their relative performance when greater amounts of wind and solar are in the system. Testing will also be conducted by augmenting these methodologies to assess potential improvements that could better account for the added RES. Finally, an optimal methodology is proposed that quantifies the needed reserves under higher shares of RES scenarios and that results in a superior economic and operational performance.

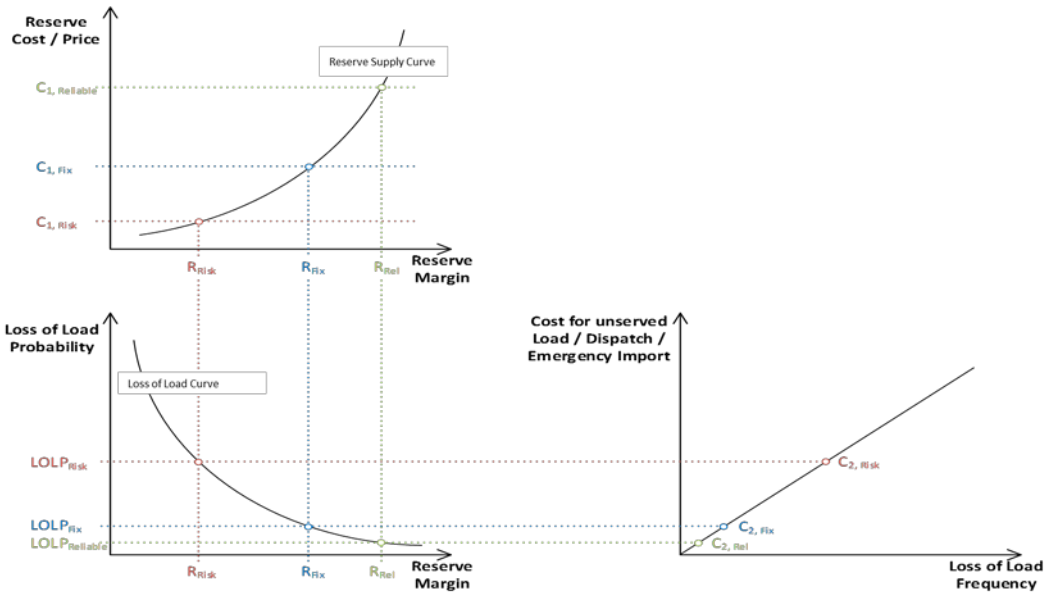

Fig. 1: Loss of load, reserve supply and opportunity cost of unserved load

Results

First results show, that high shares of renewables especially lead to a higher need of tertiary control reserves. This effect can only be reflected in methodologies which include probabilistic approaches to depict the severity of forecast errors with regard to intermittent energy production. A lack of the RES integration in the course of the reserve determination might cease either evitable cost of lost load in peak demand situations or to the contrary, major energy price crumbling. Also the frequency of the analysis and therefore updates on the reserve requirements have a great impact on the balancing adequacy of demand and supply. (Further results to be provided, work in progress)

Conclusions

Earlier research has already shown that the application of deterministic methods cannot be reasonably justified in the context of reserve planning. This fact is intensified in electric grids with high shares of RES. However, not only the methodology can be improved in today's systems but also a restructuring of the reserve market (more frequent updates of the reserve amounts, more specified reserve products and larger and more flexible balancing areas) seems recommendable. (Final conclusion to be provided, work in progress)

References

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