Study Committee C1

Power System Development and Economics

Paper 11095_2022

Methods to identify the optimal operating area of a grid booster

Markus GÖDDE, Michael DÖRING, Matthias KAHL, Michael SIEBER

umlaut energy GmbH, TransnetBW GmbH

Motivation

- The demand for transmitting electric power over long distances is rising steeply, which leads to the need for grid expansion.
- Projects for grid expansion are in delay.
- Alternative means for utilizing more of the grid's capacity are needed.
- One alternative is the shift from preventive to curative (n-1)-safety by utilizing large storage capacities ("grid booster").
- The implementation of a pilot project was the subject of the examinations presented in this paper.

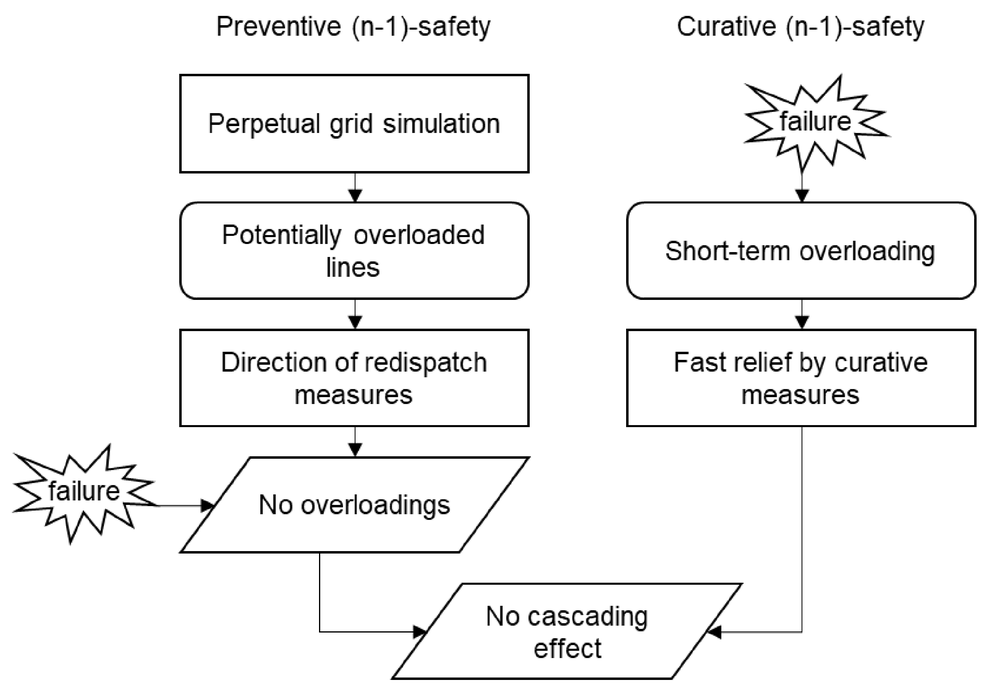

Figure 1: preventive and curative (n-1)-safety

Objects of investigation

- The project's objective was to identify the lines whose fault was to be observed to trigger the grid booster ("monitoring area") as well as to determine the power lines whose utilization can be increased due to the shift to curative (n-1)-safety ("affected lines"). It was hypothesized that only a small number of lines would be responsible for a large share of the potential reduction of preventive redispatch.
- Moreover, it was to be investigated if the implementation of the grid booster would be able to reduce the need for redispatch and if it would be possible to increase the utilization of affected lines.

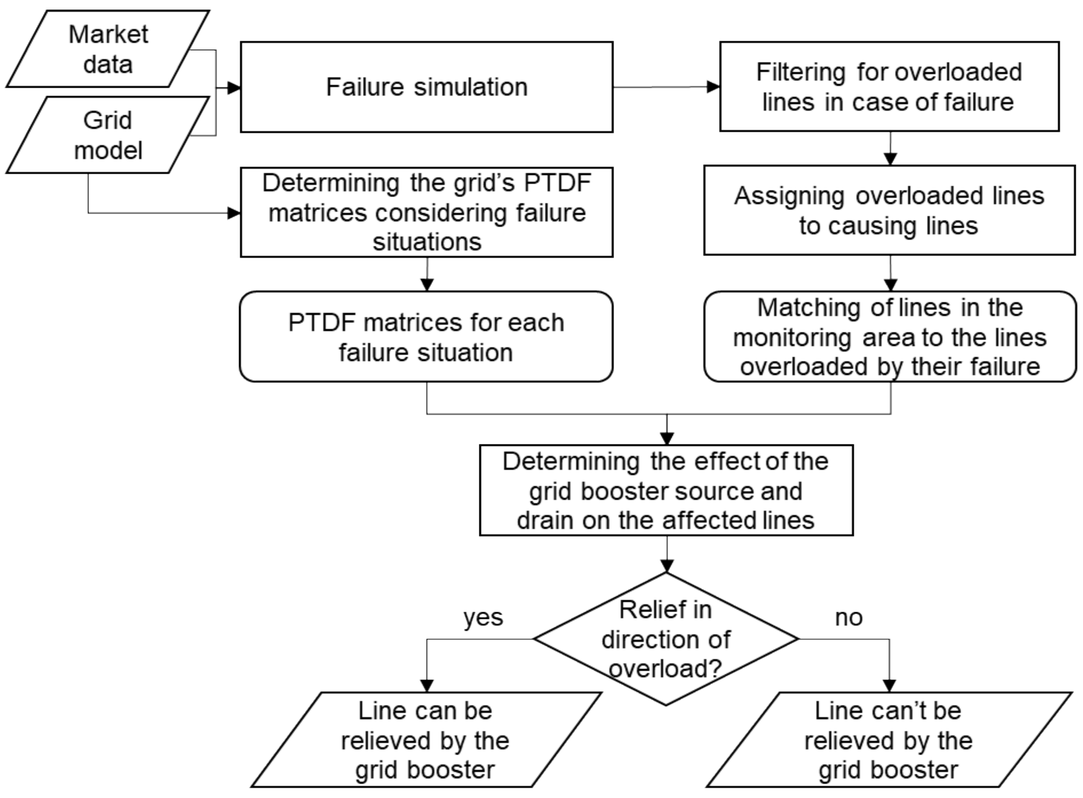

Figure 2: method for determining the lines that can be relieved by the grid booster

Method/Approach

- In grid models representing the assumed grid topologies for several different future years, the grid booster was added and redispatch optimization calculations were performed.
- Methods were developed to reliably identify the lines in the monitoring area and the possible relief of affected lines.
- Using these methods, the monitoring area and the affected lines were determined for the German extra high voltage (EHV)-grid.
- These results were subsequently verified by comparing the results of different monitoring areas (all of the German EHV-grid vs. the determined monitoring area).

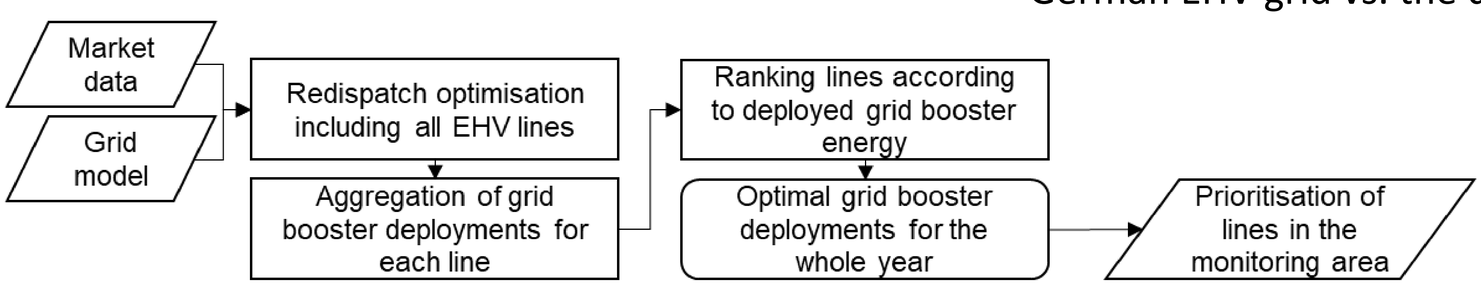

Figure 3: method for determining the lines in the monitoring area

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Experimental setup & test results

- The pilot project comprises a battery with a capacity of 250 MWh and a peak power of 250 MW in southern Germany as a grid booster source and a windfarm in the North Sea as the grid booster drain.
- The verification of the developed methods via redispatch simulations showed that already the inclusion of ten EHV lines in the monitoring area yields 80 % of the reduction in redispatch as the inclusion of the whole of the EHV-grid.
- Moreover, the increase in transmission capacity over the affected lines due to the reduction of preventive redispatch measures could be shown. For the pilot project, an increase of up to 6 % in utilization of the transmission capacity on the affected lines could be shown.

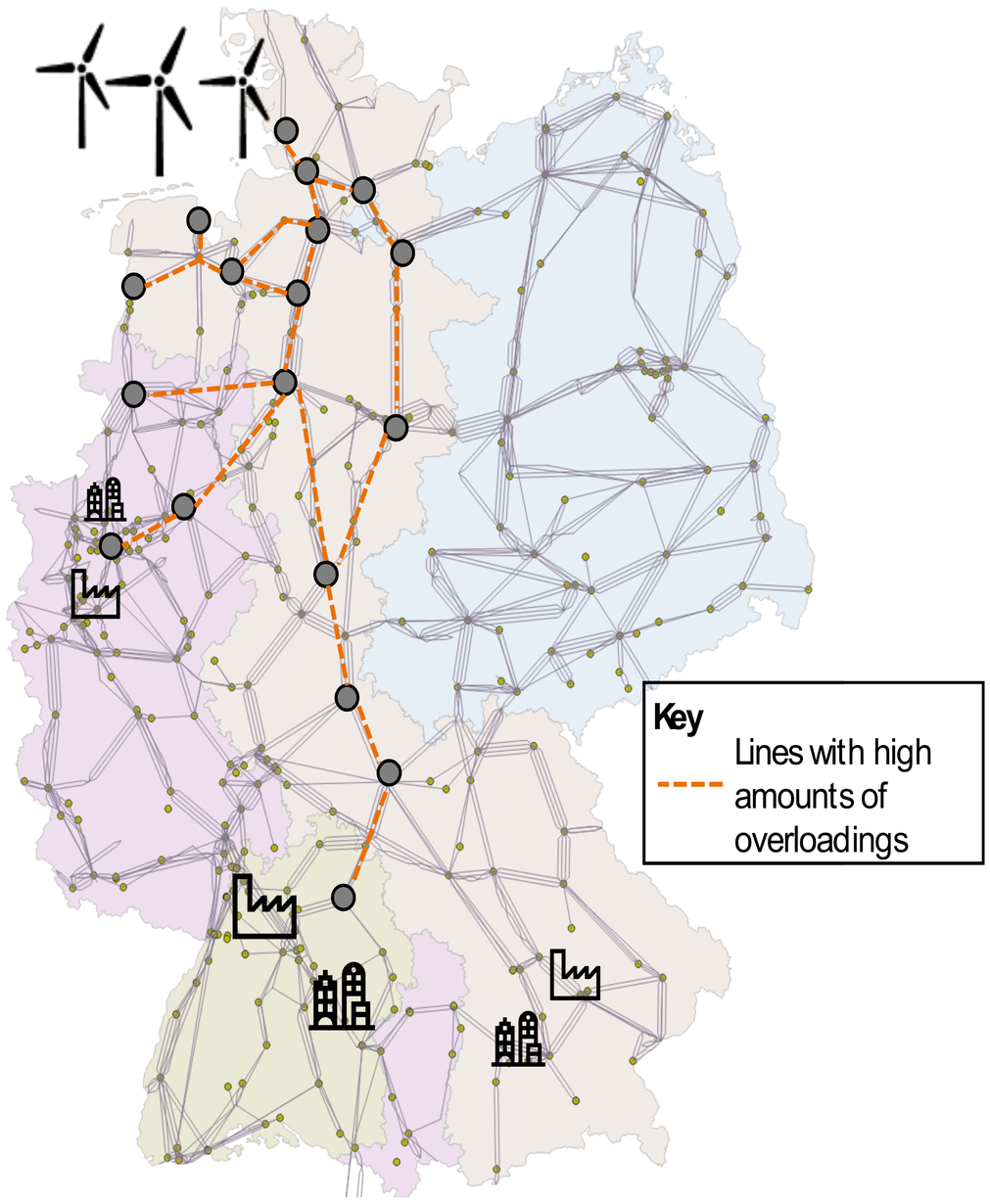

Figure 4: distribution of generation and consumption in Germany and resulting potential overloadings

Discussion

- The results support the hypothesis that a small number of lines is responsible for a large share of preventive redispatch measures.
- By targeting these lines with curative redispatch measures, such as the grid booster, a lot of savings potential in redispatch measures as well as increases in transmission capacity on existing lines can be leveraged.
- These results are limited by the accuracy of the employed redispatch optimization and future changes to the trajectory of the expansion of renewable energy sources and the grid itself. For example, the completion of HVDC-connections from northern to southern Germany will decrease the potential savings made possible by the grid booster.
- Nonetheless, the shift from preventive to curative (n-1)-safety could be shown to be able to provide for a more efficient utilization of grid assets.
- Additionally, the implementation of curative redispatch can lead to an even greater utilization of current transmission capacity when more assets are employed to provide it.

Conclusion

- Curative redispatch can be a valuable tool for a more efficient grid utilization and for the reduction of costs in the grid, especially in grids where necessary grid expansion is lagging.
- The methods developed in this project are suitable to specifically target the most rewarding lines in the grid by inclusion in the grid booster's monitoring area.
- Moreover, it is possible to determine the additional loading on the affected lines made possible by the grid booster.