

Economic Expansion Planning under Consideration of Operational Flexibilities

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Overview

Continuing changes of electrical network usage, characterized by the expansion of renewable energies as well as the integration of novel end consumers, lead to increased grid expansion requirements, especially within the medium and low-voltage grid. In order to reduce the conventional grid reinforcement, network operators can pursue cost-efficient and mostly operating cost-intensive grid-related measures. As network operators became independent entities through liberalization, the choice of grid management strategy is strongly influenced by their impact on the company's monetary benefit. This benefit depends as well on the investment payments as on the regulatory proceeds imposed by the German incentive regulation [1].

The aim of the research project is to quantify the effects of different grid management strategies on the investment behavior of network operators. Thus a method for simulating the network planning process was developed.

The interdisciplinary network planning process enables a two-stage planning process taking into account technical, regulatory and economic influencing factors based on a greedy heuristic for the target network planning process and an ant colony algorithm for the network expansion planning.

Methods

Greedy heuristic for target network planning

The developed target network planning method determines for a future time, under consideration of the available planning degrees of freedom, the current network and the supply task, a target network. A limitation of the planning degrees of freedom allows the definition of different network management strategies. One possible strategy may be, for example, the exclusive conventional network expansion. Alternatively, one possible embodiment would be the combination of the conventional network expansion and operational measures, such as the load management.

Through an iterative expansion process, the current network is expanded with the selected network management strategy, based on heuristic rules, until a secure and reliable network operation can be ensured even in future supply task.

Ant colony algorithm for expansion planning

As a part of the expansion planning, each virtual ant generates an expansion plan [2]. Each ant belongs to a colony, which learns based on the paths used by the previous colony. The economic and technical evaluation of expansion plans corresponds in reality to the length of the path. Depending on the pheromone level, expansion plans, or paths, are chosen in the model like in reality. To prevent, that untimely ant roads with unnecessarily long distances result, the pheromone is reduced on the ant paths. This increases the likelihood that other expansion plans will be developed by the ants and that convergence in one local optimum will be prevented.

Results

The technical effect of different network management strategies during network operation is simulated and the impact of different regulatory revenue mechanism of the incentive regulation is depicted. From the resulting payment effects, the monetary benefit of the company is determined according to the shareholder value concept [3]. In order to assess the impact of different network management strategies in regulated competition between network operators, different forms of competitive pressure are also simulated.

No competitive pressure

this form of competition, all network investments of the network operators are 100 % efficient. The changes of the shareholder value for different network management strategies, resulting from no competitive pressure, can be

seen in **Fehler! Verweisquelle konnte nicht gefunden werden.** (left). The exemplary investigations show that particular capital cost-intensive investments such as conventional grid expansion increase the monetary benefit for the company – Especially in situations with no competition between network operators.

Competitive pressure

Insofar as the grid operator possesses complete information on the behavior of the other grid operators and can thus base its network planning decisions on the behavior of the other grid operators, changes in the shareholder value shown in **Fehler! Verweisquelle konnte nicht gefunden werden.** (right) result for each grid management strategy. Thus, network management through operational measures such as load management has the potential to save network expansion costs, improve the efficiency value of the network operator and therefore increase the monetary benefit for the company under competitive pressure.

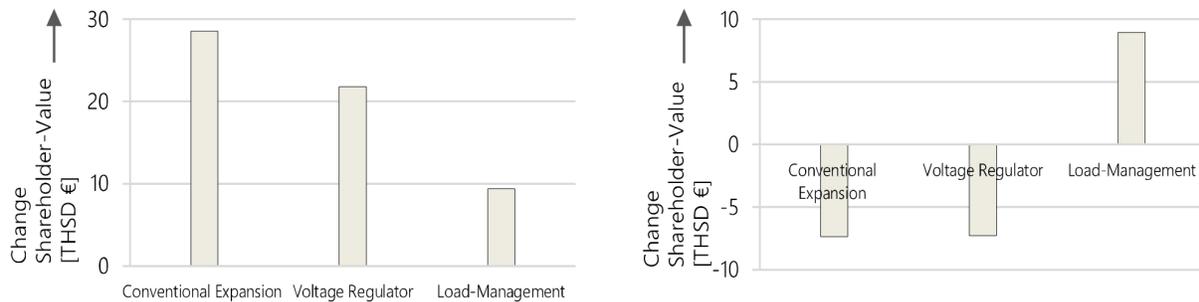


Figure 3: Shareholder-Value, No competitive pressure (right), competitive pressure (left)

Conclusions

However, network operators should pay attention to a balanced, cost-effective mix of capital cost and operating cost-intensive measures, due to the regulatory interest rate oriented on the cost of capital. Furthermore the paper shows that the monetary effect of the network management strategies depends to a considerable extent on the existing competitive situation between the network operators.

References

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