DEMAND RESPONSE IN THE BASIC MATERIALS INDUSTRY AND THE IMPACT OF POWER MARKET REGULATION

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Overview

In future power systems with high shares of variable renewable energy sources, demand response is expected to play a more active role in establishing the balance between demand and supply in electricity markets. The energy-intensive industry, and especially the the basic material producers as major users of electricity, have a high theoretic potential of flexibilising their demand (Paulus & Borggrefe, 2011), yet several technical, practical and regulatory barriers may reduce the level of demand response that can be provided (Dufter et. al., 2017).

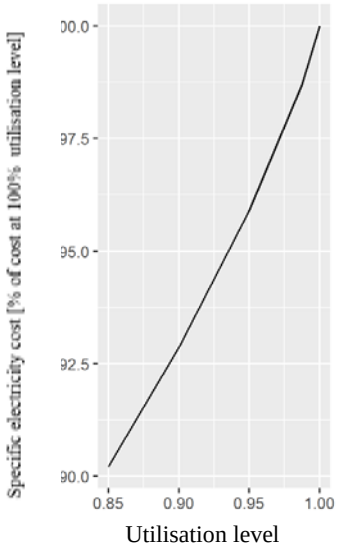
We analyse the potential of demand response and cost reductions for electricity for two processes in the material production with different characteristics, namely the chloralkali process (for ethylene dichloride production) and cement grinding, which both have storable (intermediate) products enabling them to shift demand. While chloralki process is characterised by continuous production and very high levels of utilisation, cement grinding is organised as a batch process and has lower average levels of utilisation but strong seasonal variations.

For both processes we investigate the impact of different barriers on the provision of demand response. We utilise the case of the chloralki process to analyse the impact of utilisation levels, as well as power market regulation in Germany (prices in reserves, such as frequency containment reserves, or the interruptible load reserve and grid tariffs) on the provision of flexibility in the day-ahead market, and the case of cement grinding to analyse the impact of practical barriers such as limited foresight, as well as of a limitation of production hours to current shift schedules (night shifts).

Methods

The employed method is linear programming (in the case of the chloralkali process), as well as mixed-integer programming (in the case of cement grinding) and is formulated as a cost minimisation problem of electricity procurement on the day-ahead market. The model structures and parametirisation is based on industry interviews (performed in conjunction with other researchers a broader research project) as well as publicly available data, and includes technical and practical constraints, as well as The model structure, parametirisation as well as results were validated with industry experts.

Results



For the chloralkali-process we quanitify the relation ship between usiliation level, as well as specific cost reduction of electricity procurement on day-ahead markets. At a ulisation level of a 100% (meaning the entire production capacity is running 100% of the time), there is no potential to shift demand. As the utilisation level is lowered, the specific electricity cost fall, as demand can be shifted away from hours with peaking prices. At high utilisation levels of above 95% flexibility provision is mainly provided over short durations of one or two hours, only at lower utilisation levels it is provided over several consecutive hours. Additionally, we find that the current regulation in Germany favours the provision of flexibility in electricity market reserves, as these typically have exemptions with regard to participation in other reserves, whereas participation in them often precludes the ability of companies to also offer their flexibility on the day-ahead market.

For the cement grinding process we find that limited foresight can also reduce the potential for cost reductions by providing demand response. The effect is stronger for shorter planning horizons and small storage capacities. For larger storage capacities or planning horizons of 7 days or more the effect is very small, pointing

to the importance of accurate forecasts, as well as sufficient storage to mitigate remaining uncertainties.

Conclusions

We find significant potentials for the provision of demand response and cost reductions for two processes in the basic material industry, the cloralkali process and cement grinding and quantify them using numerical methods. We furthermore identify and quantify the impact of potential barriers such as parts of the German power market regulation, as well as practical barriers such as limitation of shift schedules and limited foresight.

References

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