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ANALYSING DEMAND SIDE MANAGEMENT IN ENERGY SYSTEM MODELS

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Overview

The German electricity system has to deal with a rapidly increasing share of the volatile renewable electricity production by wind and solar as well as declining conventional generation capacity amongst others due to the phasing out of nuclear energy. Flexibility on the demand side can be a key element to achieve a secure and cost efficient integration of high shares of fluctuating renewable generation. Conclusions to an optimal use of demand side management (DSM) measures can be made with fundamental bottom-up optimisation models. This paper is giving an overview of current approaches for implementing DSM in energy system and electricity market models. The most convenient approaches are chosen and refined to conduct an analysis of the optimal use of DSM and its effects on the electricity provision in Germany.

Methods

In energy system models like TIMES (The Integrated MARKAL-EFOM System) all relevant demand side applications can be modeled explicitly. Applications with a load shifting potential are scheduled so that the total system costs are reduced based on a price signal subject to certain constraints. Applications providing only peak clipping capacities like industrial processes with high utilization rates can react to incentives. Furthermore investments in flexible demand devices and energy saving technologies can be modeled, too.
In electricity market models like E2M2s (European Electricity Market Model stochastic version) shiftable loads can be represented as negative storages while peak clipping can be fined with the gross value losses of the respective processes. Here, the focus of the detailed analysis is on the effects of DSM on the supply side and its competition to other flexibility options like feed-in management, electricity storages or power to heat processes.

Results

Convenient approaches for implementing demand side management into fundamental optimisation models are identified from literature, refined and applied on TIMES and E2M2s. Conducted model runs show that DSM can lead to significant cost reductions on both the demand and the supply side in Germany. This effect increases in the years to come due to the increasing share of volatile renewables in the electricity mix and decreasing costs for the IT connection of demand side management applications.
Explicit modelling of flexible loads can support the evaluation of DSM from an energy system as well as from a customer point of view depending on the model application. On the supply side the use of DSM leads to less investment in pump storages and gas turbines, to a more efficient operation of coal power plants and to a better yield of the available electricity from renewable energies.

Conclusions

The DSM analysis using fundamental bottom-up optimisation models shows that flexible loads can be applied to reduce costs on both the demand and the supply side. To benefit from these effects in practice, adjustments of the regulatory framework and the market design in Germany are necessary. Especially the current tariff structure and the network charge regulation are not designed to exploit the flexibility potential of the demand side.

References

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