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The effect of real-time pricing on load shifting in a highly renewable power system dominated by generation from the renewable sources of wind and photovoltaics

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The supply-demand imbalance is a major concern in the presence of large shares of highly variable renewable generation from sources like wind and photovoltaics (PV) in power systems. Other than the measures on the generation side, such as flexible backup generation or energy storage, sector coupling or demand side management are the most likely option to counter imbalances, therefore to ease the integration of renewable generation. Demand side management usually refers to load shifting, which comprises the reaction of electricity consumers to price fluctuations.

In this work, we derive a novel methodology to model the interplay of load shifting and provided incentives via real-time pricing in highly renewable power systems. We use weather data to simulate generation from the renewable sources of wind and photovoltaics, as well as historical load data, split into different consumption categories, such as, heating, cooling, domestic, etc., to model a simplified power system. Together with renewable power forecast data, a simple market model and approaches to incorporate sector coupling [1] and load shifting [2,3], we model the interplay of incentives and load shifting for different scenarios (e.g., in dependency of the risk-aversion of consumers or the forecast horizon) and demonstrate the practical benefits of load shifting.

First, we introduce the novel methodology and compare it with existing approaches. Secondly, we show results of numerical simulations on the effects of load shifting: It supports the integration of PV power by providing a storage, which characteristics can be described as “daily“ and provides a significant amount of balancing potential. Lastly, we propose an experimental setup to obtain empirical data on end-consumer load-shifting behaviour in response to price incentives.

References

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