ON THE IMPORTANCE OF ACCURATE DEMAND REPRESENTATION IN LARGE SCALE ENERGY SYSTEM MODELS: HOURLY PROFILES AND SOCIO-ECONOMIC DYNAMICS

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Energy system models are large-scale representations of real-world systems that rely heavily on mathematical optimization techniques to represent the interactions between the components of a system and are widely used as tools in the decision- and policymaking processes; however, they do not come without their limitations, as the current changes and trends in power systems have shown. On the one hand, energy system models require certainty concerning their input parameters or at least clearly defined statistical properties, and they are affected by the curse of dimensionality when more detailed representations are required, as is the case when representing variable renewable energy sources. In this work, we highlight how the uncertainty about the input parameters, particularly demand, leads to significant changes in the results obtained from the models; we use an in-house bi-hourly model of the Austrian power system and show how even a slight reduction in demand, because of an energy saving policy from example, or a shift in the patterns of consumption, due to increased adoption of electric vehicles, lead to different investment and operational decisions.

Motivation

One typical example where consumption patterns change drastically for a household is related to electric vehicles -EV-; the adoption of EV has the potential to disrupt electricity demand if planners and operators do not adequately consider its impact; for example, in a recent study in Phoenix, USA [1]; showed that household electricity consumption increased significantly after EV adoption, and, between hours 20 and 5, it doubled. The authors also showed that a co-adoption of EV and photovoltaic panels -PV- led to an overall decrease in electricity consumption. In another study [2], more technical aspects concerning the integration of Low Carbon Technologies -LCT- were analyzed; their results suggest that during winter, the grids will be stressed the most due to changes in electricity demand. Unfortunately, these aspects of electricity demand modeling are often overlooked in large-scale ESM, leading to an increased model risk.

This work aims to illustrate the importance of detailed modeling concerning electricity demand while running large-scale ESM. These models provide stakeholders with insight into power systems' evolution and help design policies to steer a system toward a desired goal. In our analyses, we use the model and results obtained from the work in the MILES project [3], where a full-year model with two-hour time steps was developed. In MILES, the goal was to analyze which would be an adequate mix of technologies and storage capacity for the Austrian power system in the year 2030; then, using this as a base case, we proceed to evaluate different scenarios for demand modeling and compare the decisions and results suggested by the model; in this work, we will consider two scenarios, first, an energy saving setting, and second, a redistribution of patterns in energy consumption due to an increased share of EV. As we will see, these two scenarios represent minor alterations to the overall demand but lead to noticeable changes in the investment and operational decisions.

Bibliography

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