SHORT AND LONG TERM STORAGE NEEDS IN THE FUTURE POWER SYSTEM: A CASE STUDY OF AUSTRIA

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Overview

The transition to renewable and sustainable energy systems is one of the major challenges facing energy systems worldwide. This is particularly crucial in Europe, where ambitious targets for increasing the share of renewables in the energy mix with the "Clean energy for all Europeans package" have been set. To successfully integrate a high share of variable renewables into the energy system, finding ways to balance supply and demand will be necessary, and storage technologies will play a crucial role in this effort. The European Parliament has also highlighted this in the resolution on a comprehensive European approach to energy storage, which says that due to the flexibility increase, more energy storage facilities will be requiured (EU, 2020). Austria, in particular, is an interesting example, with already about 9 TWh of electricity generation from intermittent sources such as wind and solar (excluding hydro) in the year 2020 (from about 1.6 TWh in 2005) and a strong target of 100 % on-balance renewable electricity in 2030 with the "Renewable Expansion Law (EAG)" (BMK, 2022). In addition, a relatively high capacity of pumped storage power plants is available in Austria, which is also the dominant storage technology worldwide, accounting for 96% of installed power capacity and 99% of storage energy volume (Blakers et al., 2021).

These two circumstances in Austria raise the question of whether additional storage capacities will be necessary given the ambitious expansion targets and to what extent, depending on the expansion of renewable capacities and the respective costs of additional storage capacities. On the other hand, the question arises of which storage technologies should be used, in view of the fact that the expansion of pumped storage will be limited due to the topography. Furthermore last but not least, the question should be answered to what extent seasonal storage will be necessary and whether the necessary amounts of electricity will be available. The storage technologies and demand side management that are being investigated are shown in Figure 1.

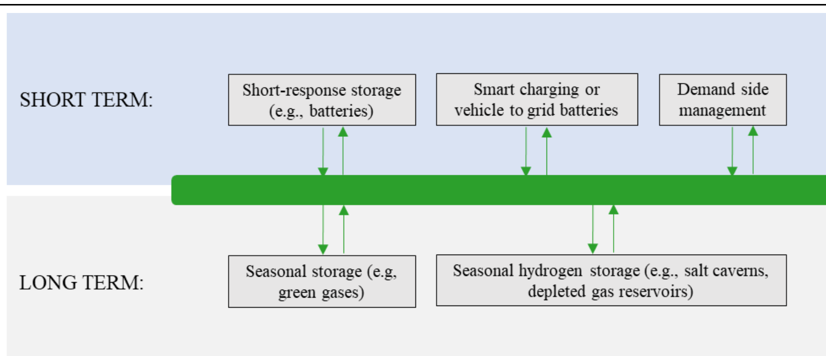

Fig. 1. Investigated storage technologies and demand side management

Methods

The above research questions are answered by means of a model of the Austrian electricity market with input data of the storage technologies shown. Our method is thus based on an hourly linear optimization model of the Austrian electricity market, schematically shown in Figure 2, the definition of different renewable expansion targets and the resulting necessary short-term or long-term storage capacities. Which storage technologies are used in each case is decided based on the technical possibilities of the technology (short-term or long-term storage) and the cost analysis.

Results and Conclusions

Some studies have already been conducted on storage requirements in electricity systems with a large share of renewables. Schill (2014) was the first to analyze the electricity sector in Germany, followed by Zerrahn and Schill (2017), who conducted a comprehensive review of electricity storage models. They demonstrated that the need for additional storage capacity remains moderate as long as alternative flexibility options are available, even when up to 80% of electricity is generated from variable renewable energy sources (Schill and Zerrahn, 2018). Steffen and Weber (2013) also found that increasing the amount of variable renewable energy sources (between 40-60%) does not necessarily require a larger amount of storage and Böcker et al. (2015) looked into even higher shares of renewables (up to 80%) and showed that the amount of storage required is heavily influenced by investment costs and political targets. However, it will be essential for a well-functioning energy portfolio in the year 2040. In this work, we will investigate these points for the country specifics of Austria (e.g., 100% renewables, large capacity of pumped storage hydro).

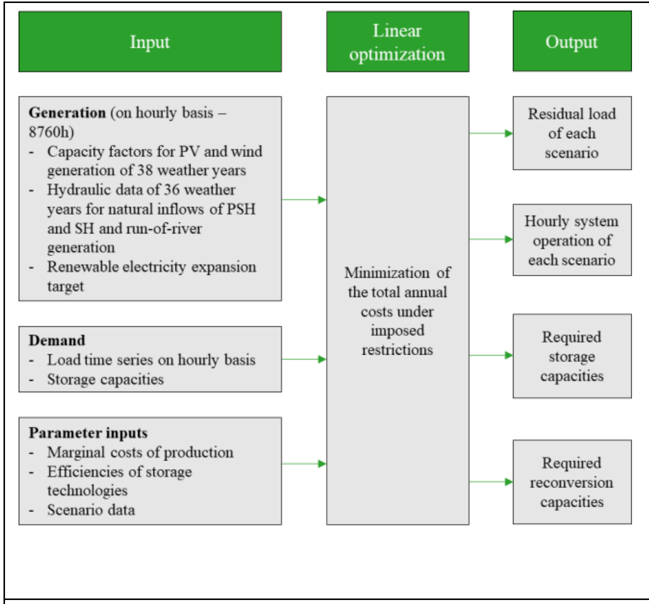

Fig. 2. Model illustration

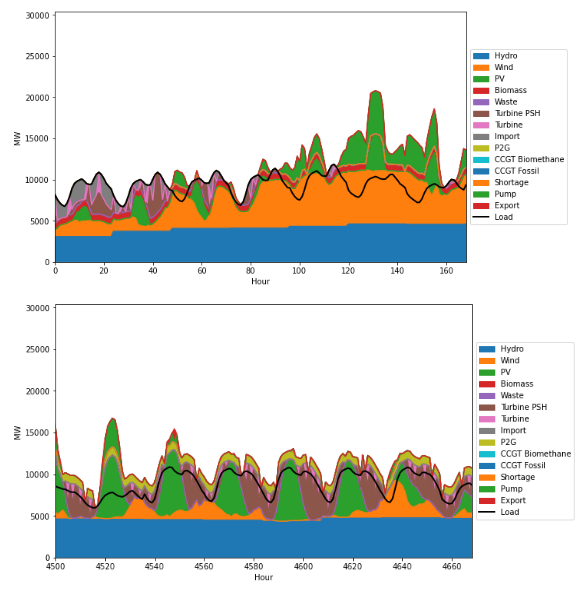

Fig. 3. Preliminary results of an optimization scenario

The results are intended to show how the future renewable power system may look based on different expansion scenarios and weather years. The respective use of storage, other flexible generation (biomethane) and different import/export scenarios will be optimized, see Figure 3. Further, the technical necessity, as well as the economic feasibility of additional storage capacities, should be investigated.

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