

By 2050, the Baltic States are predicted to significantly increase their electricity storage capacity, with sodium-sulfur batteries and compressed hydrogen leading the way, while the growth of pumped hydro storage remains limited.

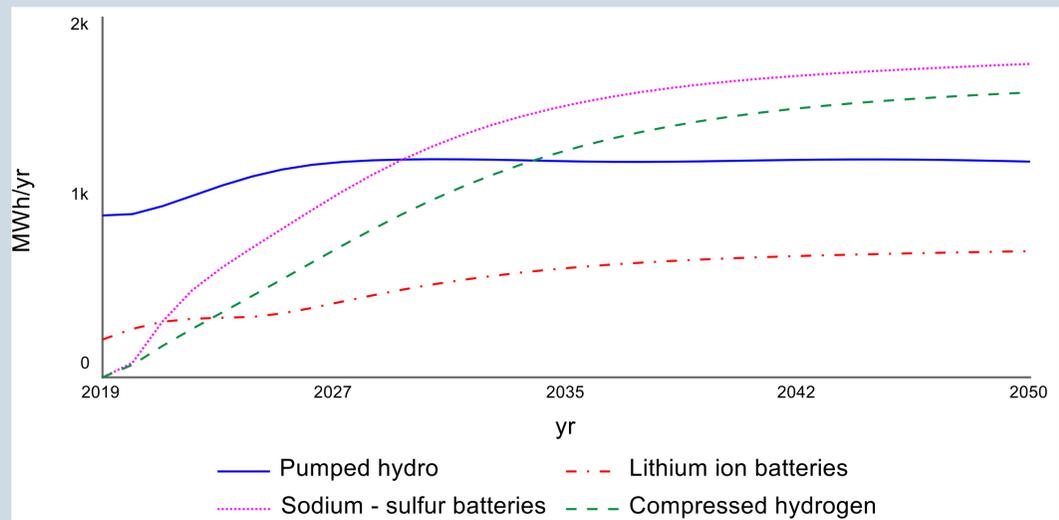


Fig. 1. Estimated installed capacity trends for electricity storage technologies obtained from TOPSIS analysis of the Baltic States based on the baseline (BAU) scenario

Introduction

The share of renewable energy sources (RES) in the energy mix is continuously increasing, creating new challenges in balancing supply and demand. Electricity storage systems play a critical role in addressing these challenges by enhancing grid reliability and enabling the deeper integration of RES. This study analyzes electricity storage technologies using multicriteria and system dynamics methods to assess their role in supporting a sustainable energy transition.

Methodology

This study uses multi-criteria analysis (TOPSIS) and Analytical Hierarchy Process (AHP) to evaluate and rank electricity storage technologies for the Baltic region (see fig.2.).

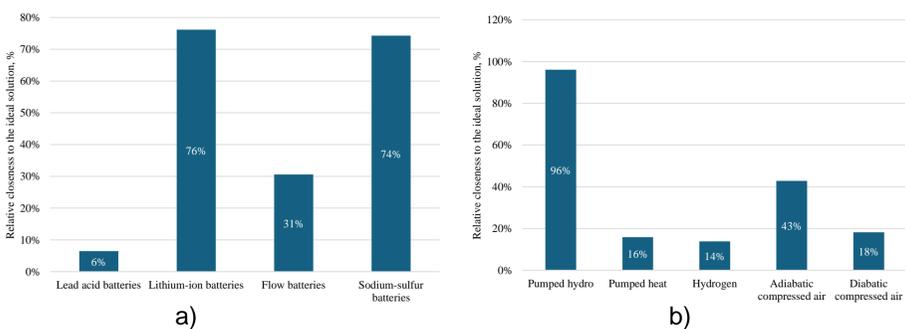


Fig. 2. TOPSIS analysis results with AHP criteria weights

The top technologies were modeled using system dynamics in Stella Architect, simulating the interplay of electricity generation, consumption, and storage (see fig.3.).

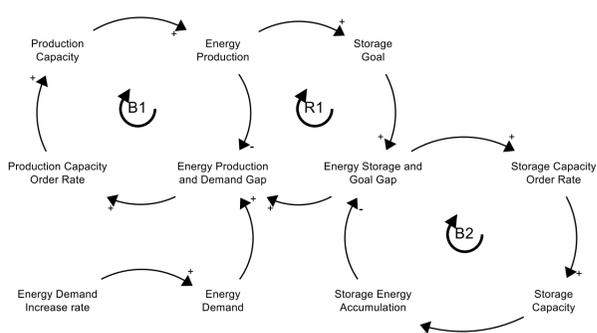


Fig. 3. Causal loop structure of the model

Results

Four scenarios were simulated to analyze the achievable and required electricity storage capacity in the Baltic States, varying the demand change rate (DCR) by 0%, $\pm 3\%$, or historical trends. Each scenario considered different electricity generation mixes: wind and solar (VES/SES), hydro and cogeneration (HES/CHP), and business as usual (BAU) based on the 2019-2023 generation portfolio (see fig. 4.).

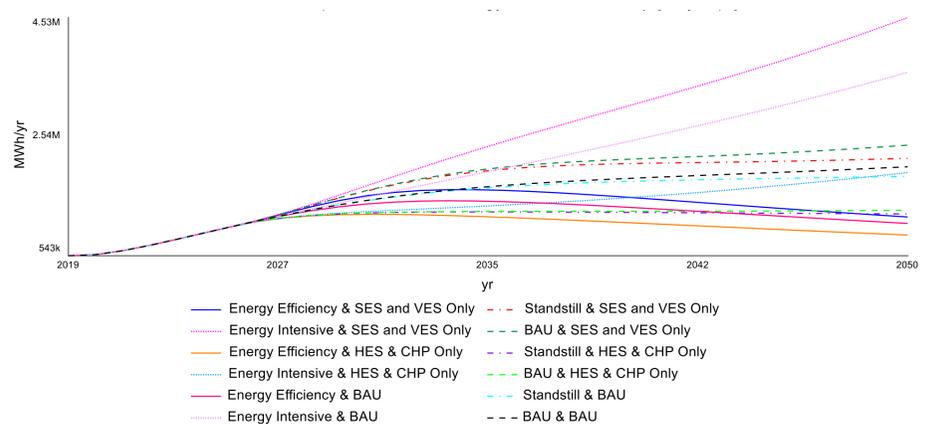


Fig. 4. Installed storage capacity target in the Baltic States

Conclusion

With TOPSIS and AHP were identified suitable storage options for the Baltics. Sodium-sulfur batteries and compressed hydrogen installed capacities are expected to grow significantly by 2050, while pumped hydro is limited by geography, and lithium-ion capacity will grow moderately. Four scenarios highlight the impact of electricity demand trends on storage needs. Energy-efficient behavior reduces storage requirements. The model can be adapted to other countries with local data and should incorporate geography, funding, and policies for greater accuracy.