Techno-economical modeling and simulations for redox flow batteries

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Due to the significantly increasing growth of renewable energies worldwide, the need for stationary storage systems to compensate for supply shortages is growing. One promising technology is redox flow batteries, in which the energy is stored in flowing media and thus energy and power can be scaled separately. There is now an almost unmanageable number of different types (chemistries) of redox flow batteries. Especially in organic redox flow batteries, new active materials are constantly being developed and investigated [1]. The best studied and commercialized type is the vanadium redox flow battery. Currently, more and more installations are taking place in the MW range, but the costs must be further reduced to enable a successful establishment in the market. In terms of cost, there are a variety of issues that can enable effective and targeted investigations in applied research and development, on the one hand, and evaluate the application potential of novel chemistries, on the other.

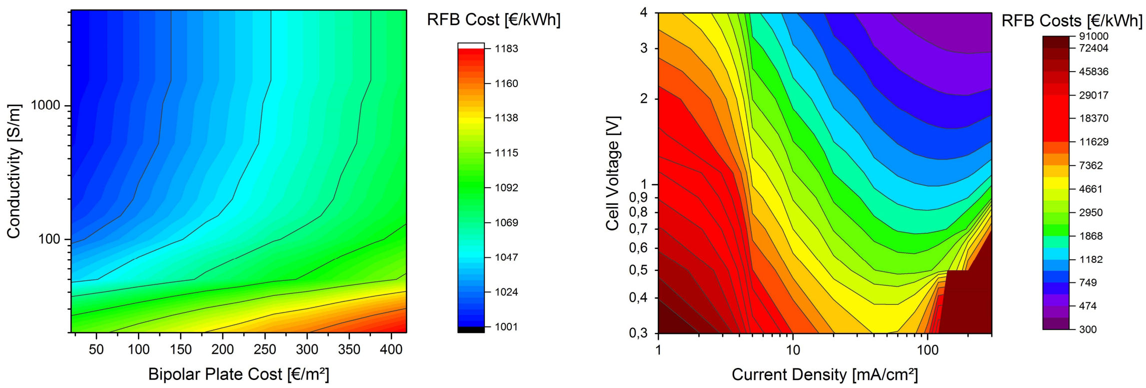

Figure 1 left) Dependence of RFB investment costs on conductivity and cost of bipolar plates and right) Dependence of RFB investment costs on cell voltage and current density (simulation results for a 10 kW / 120 kWh RFB at pilot plant scale).

For this purpose, a techno-economic model for redox flow batteries was developed and simulations were performed using pilot plant values that were as real as possible. First, a 10 kW / 120 kWh VRFB was studied and the cost distribution was determined [2]. The costs were distributed approximately 1/3 to the vanadium solution, the stacks and the rest of the system. Significant optimization potential was thus found by increasing the current density for the stacks or reducing the cost of the components of the stacks by using other materials such as thermoplastic bipolar plates instead of expensive fuel cell plates. In addition to the cost structure of the VRFB, general studies were conducted. For example, the cost/performance impact of bipolar plates or a different cell voltage due to e.g. different redox couples were investigated. Furthermore, an analysis of an organic laboratory battery based on methyl viologen and TEMPO-OH was performed and compared with a VRFB laboratory cell.

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[1] E. Sánchez-Díez et al., Journal of Power Sources, 481, 228804 (2021).

[2] J. Noack, L. Wietschel, N. Roznyatovskaya, K. Pinkwart, and J. Tübke, Energies, 9, 627 (2016).