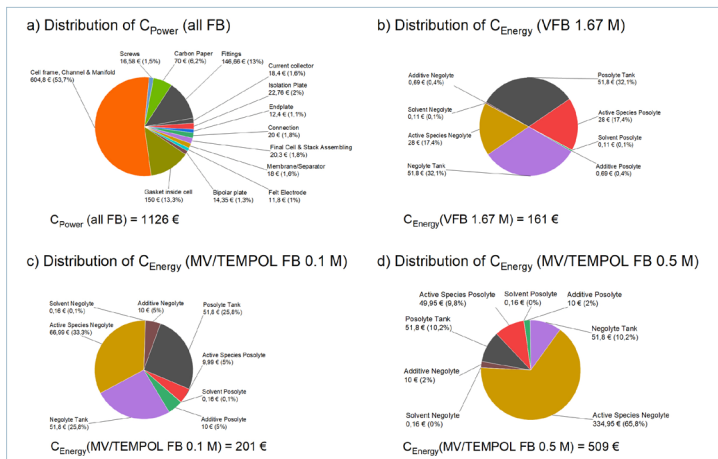


TECHNO-ECONOMIC MODELING FOR THE ANALYSIS AND OPTIMIZATION OF FLOW BATTERIES

The techno-economic model developed at the Fraunhofer Institute for Chemical Technology (ICT) can be used to model both organic and inorganic aqueous flow batteries and subject them to a wide range of sensitivity analyses.

Both technical aspects (energy density, power density, current, resistances, etc.) and economic aspects (energy-specific costs, power-specific costs, production or manufacturing costs, etc.) are included in the model. Efficiencies (voltage, coulomb and energy efficiency) were also included as common comparative variables between batteries.



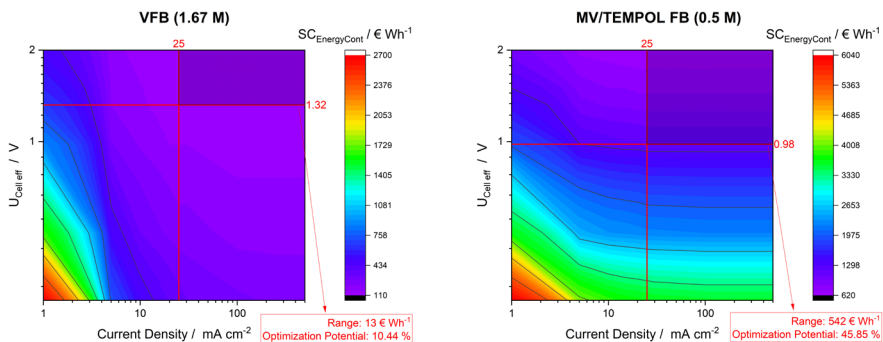
Calculated power (a) and energy-related investment cost distributions for flow batteries with 1.67 M Vanadium (b), 0.1 M MV/TEMPOL (c), and 0.5 M MV/TEMPOL (d) using laboratory-scale cells.

Based on these data, the model is able to represent classical cost distributions of the respective areas such as Energy, Power and Control & Connect and also sensitivity analyses of the effects of the variation of individual component properties with respect to the specific energy content or power costs.



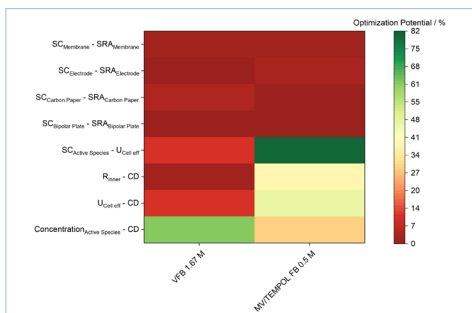
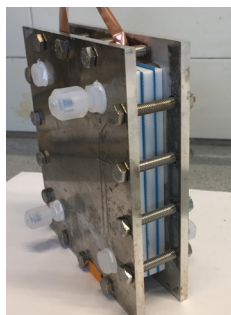
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These sensitivity analyses can help in the optimization of common flow batteries, which are often still necessary for a successful broad market entry and usually concern specific application cases. Not every technically possible improvement has the same positive influence on the economically relevant performance or energy-related specific costs.



Example of a sensitivity analysis of the influence of effective cell voltage and current density on the energy-specific costs of Flowbatteries.

The additional evaluation of these sensitivity analyses according to the optimization potential lying in them, prioritizations of the optimization approaches possible in the concrete can be obtained.



Optimization potential of the Sensitivity Analyses performed with respect to the energy-specific investment costs of laboratory-scale VFBs with 1.67 M vanadium solutions and those with 0.5 M MV/TEMPOL.

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