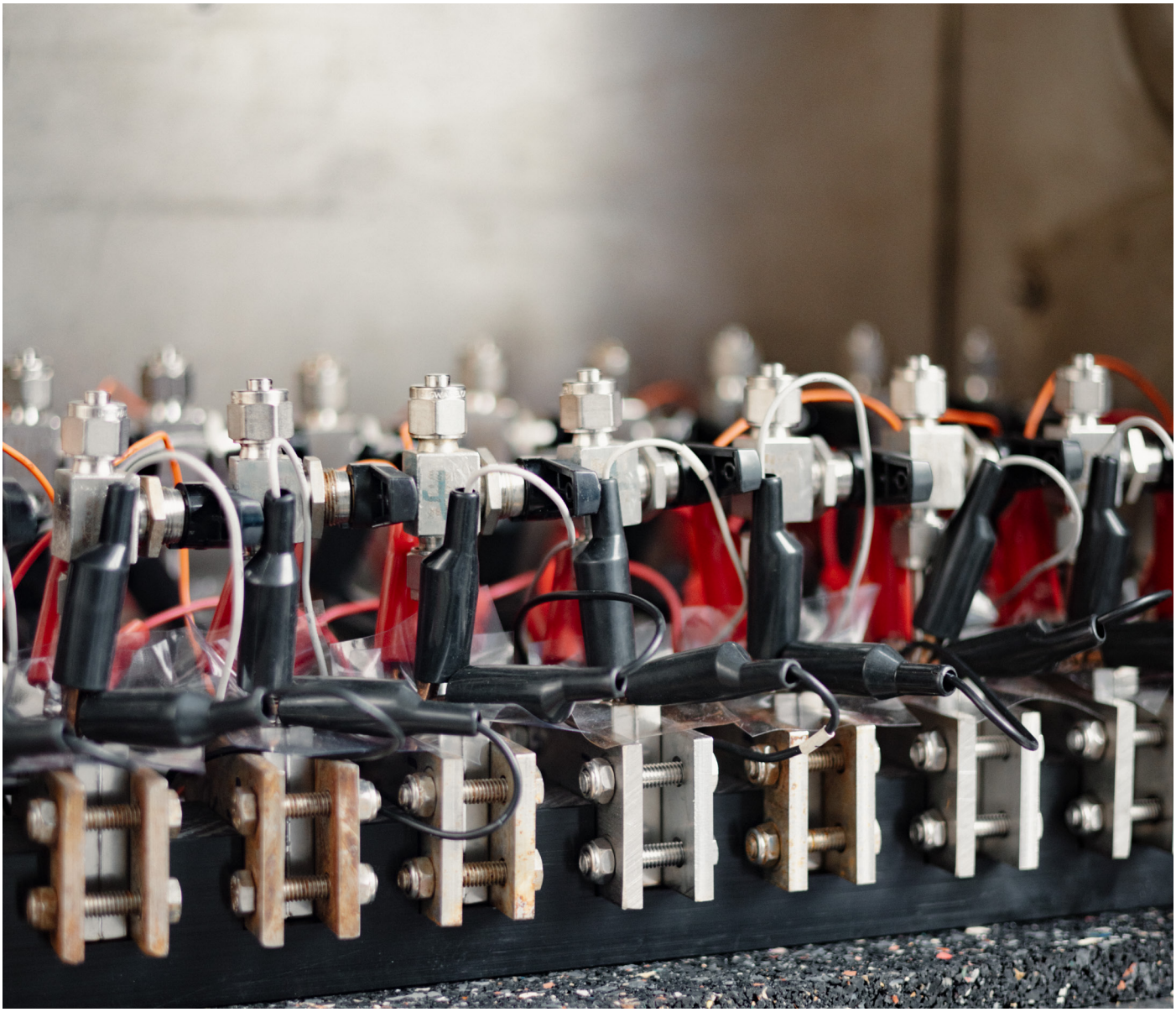

HPB Technology

Status 03/2025

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Doc No. 250324-01

HPB Technology is consistently monitored by external experts.

The tests and measurements described were conducted on a limited number of HPB Solid-State Battery sample cells. Not all tests and measurements were performed on every sample. Specifications and performance characteristics of final HPB product will depend on the final design of the battery package and may differ from those of initial low volume samples.

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HPB Solid-State Battery (HPB SSB)

Cycle life

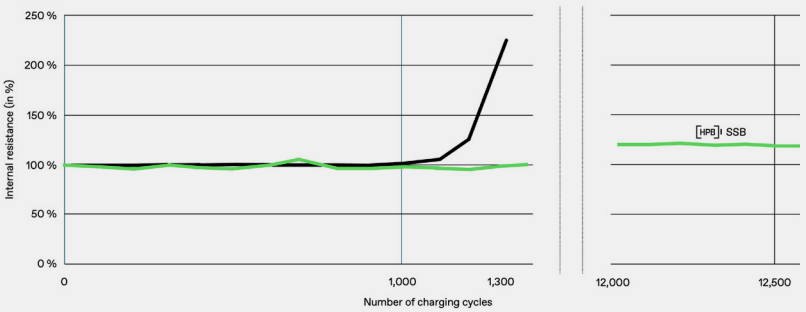
>12,500 and ongoing

While conventional lithium-ion batteries have to be replaced after approx. 1,250 charging cycles* – with hourly charging and discharging – the **HPB Solid-State Battery** currently has at least 12,500 charging cycles, with a comparable load.

Since these cycle life test cells have not yet reached the end of their life, this number will continue to increase steadily.

*Source: https://www.sciencedirect.com/science/article/pii/S2666546821000355

1C/1C, 0-100 % SOC, RT

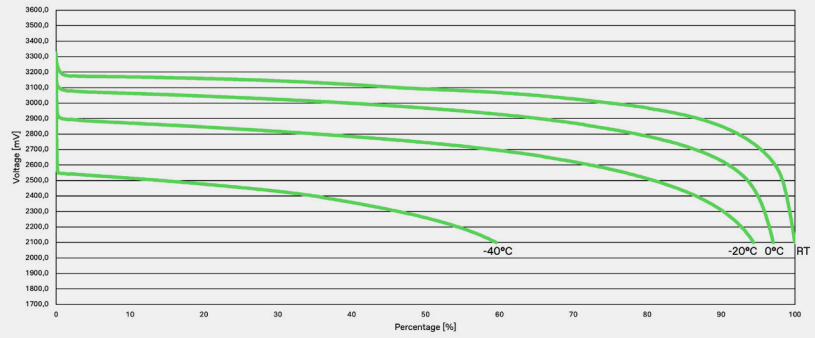


Discharge Capacity

High performance at low temperatures

Where other batteries without external battery heating give up, the **HPB Solid-State Battery** is still in its comfort zone: Even at -20 °C/-4 °F, the extractable capacity is more than 90 % – tested at a robust discharge rate (1C).

Charge: CC-CV 0.5 C 3.6V, 0.1 C cut-off at 25 °C (RT)
Discharge: 1C 2.1 V, cut-off



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Technology comparison

HPB Solid-State Battery (HPB SSB)

Wh/kg and cycle life

Longer lasting and more efficient

A key parameter of battery storage systems is their specific energy: the maximum amount of electrical energy that can be stored in relation to the battery mass, is expressed in watt hours per kilogramme (Wh/kg).

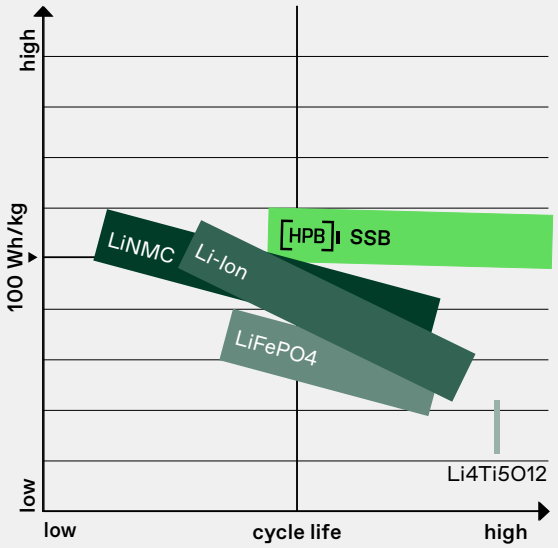
With stationary storage systems, the specific energy generally decreases with increasing cycle life, which must be compensated for by larger battery storage systems depending on the application – with consequences for resource requirements and the environment.

Compared to other long-life storage systems, the **HPB Solid-State Battery** also has significantly higher specific energies in the long term. A battery storage system with HPB Technology can therefore be dimensioned significantly smaller for an identical application.

When selecting a storage system, the specific energy parameter must be considered in the context of the other battery characteristics.

For example, the fast-charging capability (C-rate) is another lever for resource efficiency. We have clearly summarised these relationships in our white paper „Rightsizing“.

Source:
https://www.highperformancebattery.ch/global/downloads/211008_Impulses_for_the_energy_transition_-_Rightsizing_-_but_the_right_way.pdf?m=1636392926&



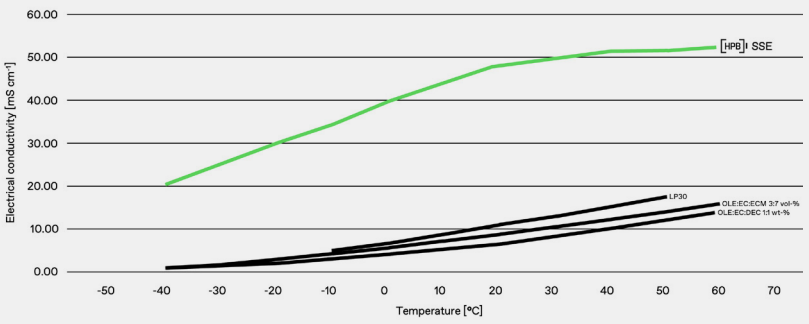
HPB Solid-State Electrolyte (HPB SSE)

Conductivity

Higher conductivity over the entire temperature spectrum

Compared to the liquid electrolytes commonly used today, the **HPB Solid-State Electrolyte** has enormously improved conductivity. This is decisive for the available power from the battery cell. The **HPB Solid-State Electrolyte** shows a signaficantly higher conductivity at -40 °C/-40 °F than conventional liquid electrolytes at their optimum of +60 °C/+140 °F.

temperature range: from -40°C to +60°C/-40°F to +140°F



*Sources: [1] J. Landesfeind, H. A. Gasteiger. J. Electrochem. Soc. 2019, 166(14), A3079-A3097. URL: https://iopscience.iop.org/article/10.1149/2.0571912jes | [2] T. R. Jow, K. Xu, O. Borodin, M. Ue (Ed.), Electrolytes for Lithium and Lithium-Ion Batteries, 2014, Modern Aspects of Electrochemistry Vol. 58, Springer, New York. | [3] T. B. Reddy (Ed.), Linden's Handbook of Batteries, 2010, 4th ed., McGraw-Hill Education Ltd.

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Technology comparison

HPB Solid-State Electrolyte (HPB SSE)

Conductivity and processability

More conductive and easy to process

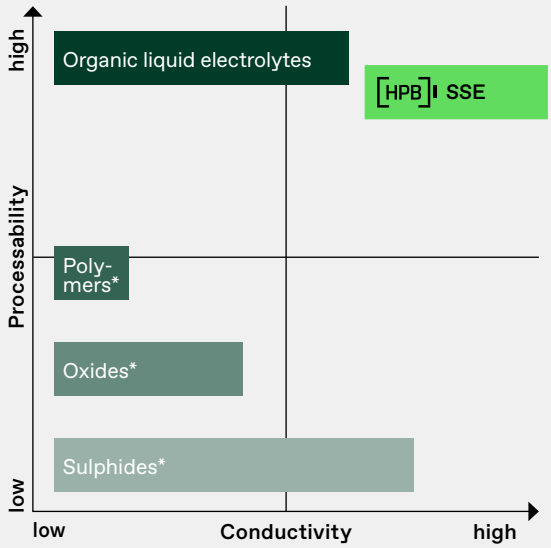
The **HPB Solid-State Electrolyte (SSE)** achieves outstanding conductivity values across the entire temperature spectrum and therefore not only outperforms conventional organic liquid electrolytes, but also the conductivity values of other solid-state electrolytes (polymers, oxides and sulphides).

Compared to other solid-state electrolytes (polymers, oxides and sulphides), however, the **HPB Solid-State Electrolyte** is much easier to produce, as it can be manufactured based on known production processes from conventional lithium-ion batteries with liquid electrolytes.

In a two-stage process during cell production, the starting materials for forming the **HPB Solid-State Electrolyte** are first introduced from the production of the raw electrodes to the electrode stacking. By adding the final components as a liquid, similar to the liquid electrolyte filling of conventional lithium-ion batteries, the chemical reaction to form the **HPB Solid-State Electrolyte** in the battery cell begins.

The conductivities and the specific challenges of industrial production of the other solid-state electrolytes (polymers, oxides and sulphides) are clearly described in the Fraunhofer Institutes “Solid-state batteries Roadmap 2035+” study.

Source:
https://www.isi.fraunhofer.de/content/dam/isi/dokumente/cct/2022/SSB_Roadmap.pdf



*Solid-state electrolyte

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