Lithium-ion battery 390 kWh

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The numbers are based on market demand forecasts for 2021-2030 (refs. 7,8,9,11,13) and 2030-2040 (refs. 10,12) combined with a forecast of market share of cathode chemistries14. All market data and calculations can be found in Source Data Fig. 1. NCA, nickel-cobalt-aluminium.

The SSP is a framework of possible narratives for possible the future of humanity until the year 2100 (ref. 15). Five different possible futures of humanity are described, that is, sustainability (SSP1), middle of the road (SSP2), regional rivalry (SSP3), inequality (SSP4) and fossil fuel (SSP5)15. For the future demand for batteries, scenarios SSP1, SSP2 and SSP5 are the most important10.

In this Analysis, our aim is to determine how much energy is required for the current and future production of LIB and PLIB cells on a battery cell level and on a macro-economic level. Material mining and refining were excluded from this study due to their complexity.

The different sizes of the circles represent the different sums of energy (kWhprod) of electricity and natural gas. Detailed numbers can be found in Source Data Fig. 3. The main bars show the calculated mean value. The error bars show the s.d. resulting from the uncertainties in the expert assessments. Sixty experts were interviewed (n = 60). Any battery materials are excluded from the assessment. EOL, end of line; Tdp, dew point temperature. Wel., welding; Pac., packaging; Fil., electrolyte filling; Clo., closing.

Detailed numbers can be found in Source Data Fig. 4. The main bars show the calculated mean value. The error bars show the s.d. resulting from the uncertainties in the expert assessments. Sixty experts were interviewed (n = 60).

We assumed that battery cell production will be improved markedly in the future, so the demand for energy will decrease. The most important effects are technology improvements, use of heat pumps, learning effects and economies of scale35. The calculations are in Source Data Fig. 5.

a,b, Energy consumption for LIB cell (a) and PLIB cell (b) production. It is assumed that the current energy consumption will be improved substantially by technology improvements, heat pump use, learning effects and economies of scale. Detailed numbers can be found in Source Data Fig. 6. The main bars show the calculated mean value. The error bars show the s.d. resulting from the uncertainties in the expert assessments. Sixty experts were interviewed (n = 60).

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