Techno-Economic Evaluation of Continuous Coating of Liquid Lithium for Battery Anodes

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Motivation

- Lithium-metal anodes are considered a key enabler for next-generation battery technologies due to their exceptionally high theoretical capacity. However, **industrial-scale manufacturing remains a major bottleneck**.
- Conventional production routes rely on **energy-intensive rolling, laminating, or vacuum-based processes**, which are associated with **high material losses, limited scalability, and substantial capital expenditure**.
- Continuous coating of **liquid lithium** offers a promising alternative, potentially enabling **high material utilization, simplified process chains, and cost-efficient large-scale production**. A quantitative techno-economic evaluation is therefore essential to assess the industrial viability of this approach.

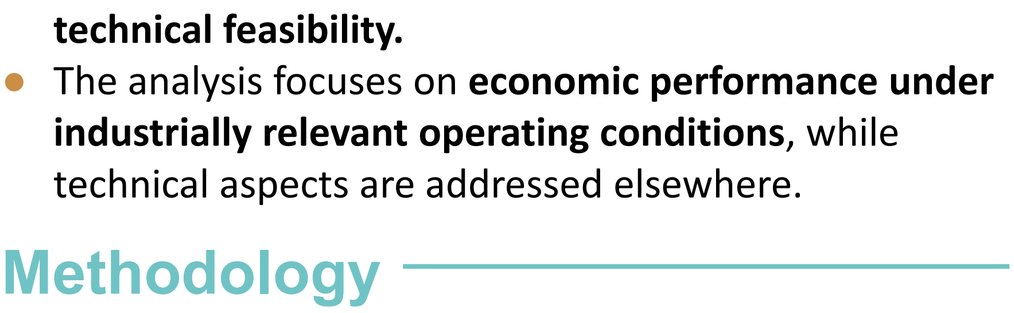
Objective

- The objective of this work is to perform a **techno-economic evaluation** of a **continuous coating process for liquid lithium**, based on **previously demonstrated technical feasibility.**
- The analysis focuses on **economic performance under industrially relevant operating conditions**, while technical aspects are addressed elsewhere.

Methodology

The economic assessment is based on the following process assumptions:

- Coating speed: 10 m min^{-1}
- Web width: 100 mm
- Operation: 8 h shift, 250 production days per year
- Process temperature: > 180 °C
- Lithium Price: US$25 kg-1



Lithium layer thicknesses of 10 µm and 50 µm were evaluated to represent different application scenarios, including lithium-ion and lithium–sulfur batteries.

Results

The continuous slot-die coating process enables industrially relevant area throughput at moderate line speeds.

- High throughput: 480–960 m^2 at 10 m min^{-1}, corresponding up to **0.06 GWh yr^{-1}– 0.3 GWh yr^{-1} per line.**
- Efficient lithium use: 5.3 g m^{-2} (10 µm) and 26.7 g m^{-2} (50 µm), resulting in **0.6t yr^{-1} lithium** demand per line, respectively, with near-100% material utilization.
- Low process overhead: Energy demand for melting (< 1 MJ kg^{-1}) is negligible compared to material costs, yielding a raw-material-dominated cost structure with moderate CAPEX.

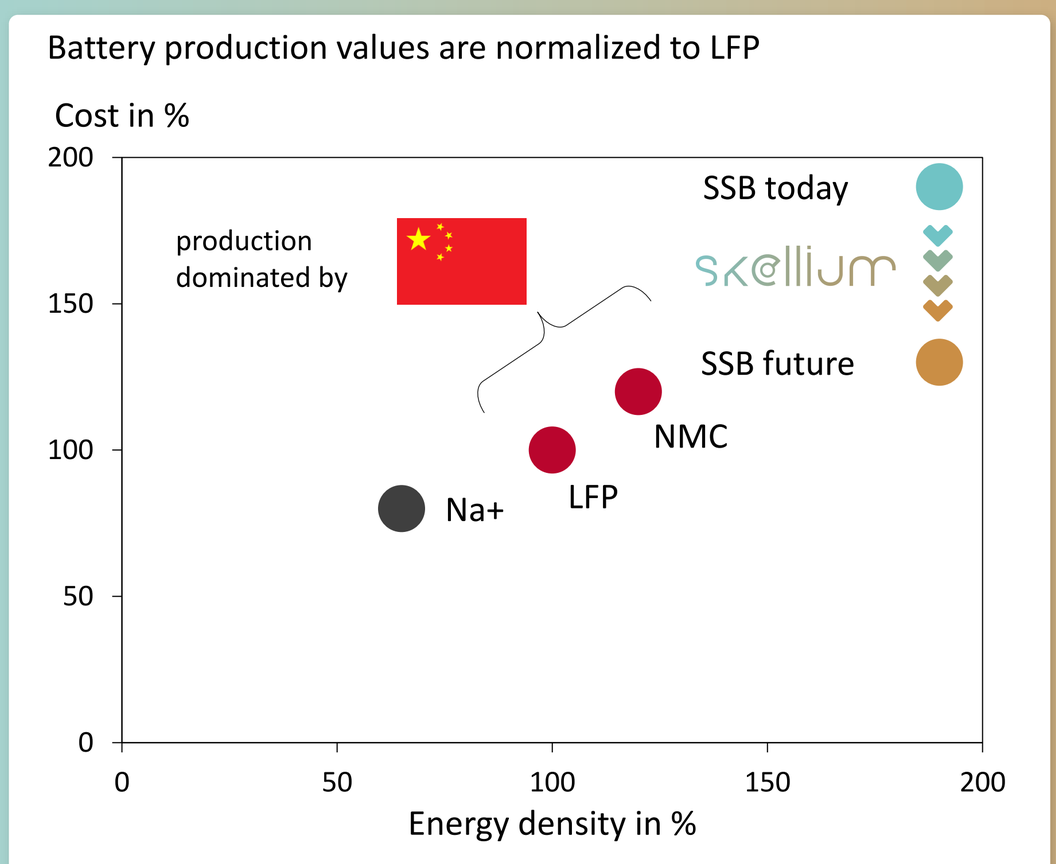
Discussion

At 100 mm web width, one coating line delivers up to ~0.30 GWh yr^{-1} with lithium material costs below 0.7 USD m^{-2} and near-100% material utilization.

Key advantages include:

- raw-material-dominated and transparent cost structure
- high material efficiency
- moderate capital investment due to roll-to-roll compatibility
- efficient scalability toward GWh-level production

The process therefore provides a strong foundation for the industrialization of lithium-metal anode manufacturing, particularly for applications with elevated lithium demand per unit area



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