Sulfide-based All-Solid-State Battery Pouch Cell Production – An Environmental Assessment

Fraunhofer IST

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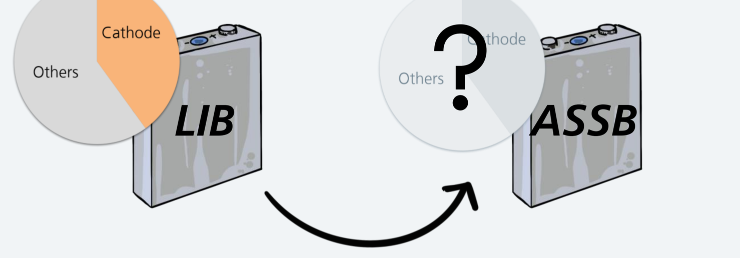
MOTIVATION

- All-Solid-State Batteries (**ASSB**) as **promising technical enhancement** of conventional LIB technology due to theoretical higher energy densities and improved safety aspects
- ASSB as a **technology under development** (low TRL): research focus on materials, cell concepts, production processes

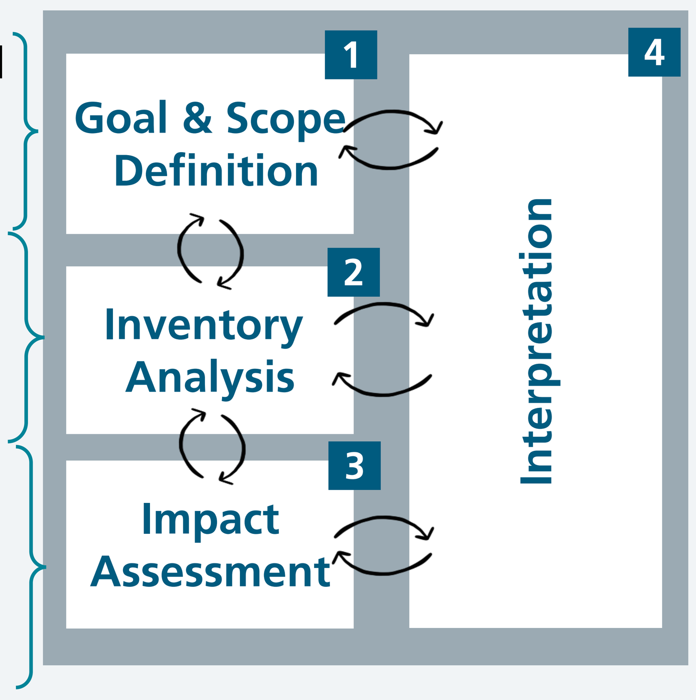
Environmental Impacts



➡ **Goal:** Evaluate environmental impacts of the technology in an early stage of development

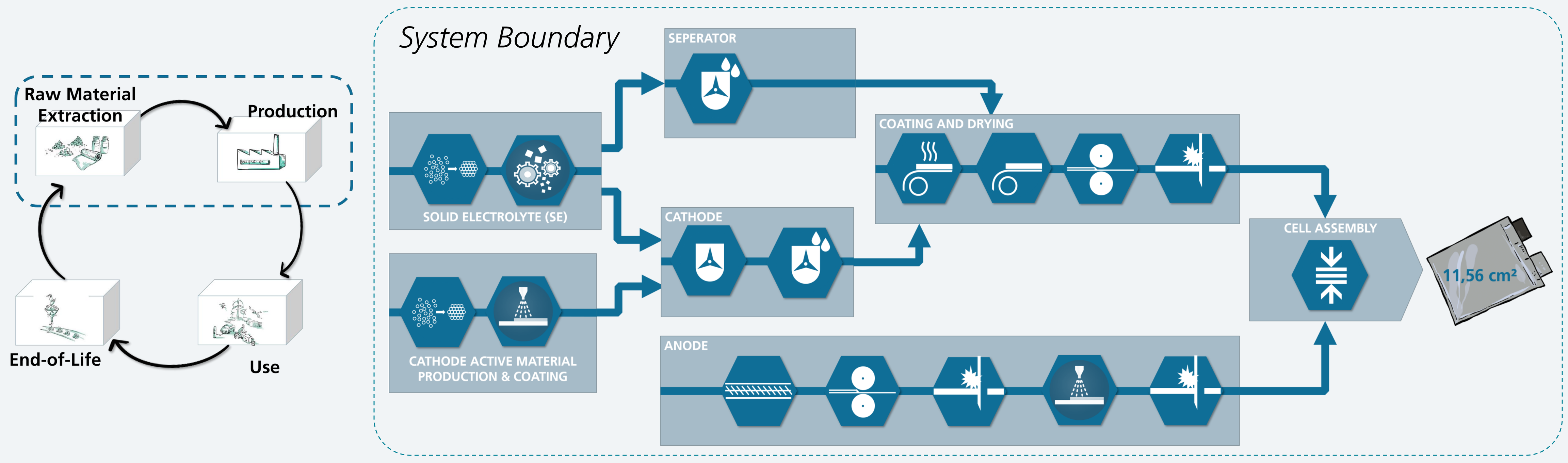
LCA METHODOLOGY

- Goal: Identification of environmental hotspots
- System boundary: Cradle-to-Gate
- Process data from energy measurements on laboratory scale
- Supplemented by literature values
- Software: python-based modeling in brightway2
- Database: ecoinvent3.9
- LCIA Method: CML v4.8 2016



PROCESS CHAIN

A Cradle-to-Gate Life Cycle Assessment is performed considering material and energy flows as well as waste and emission flows

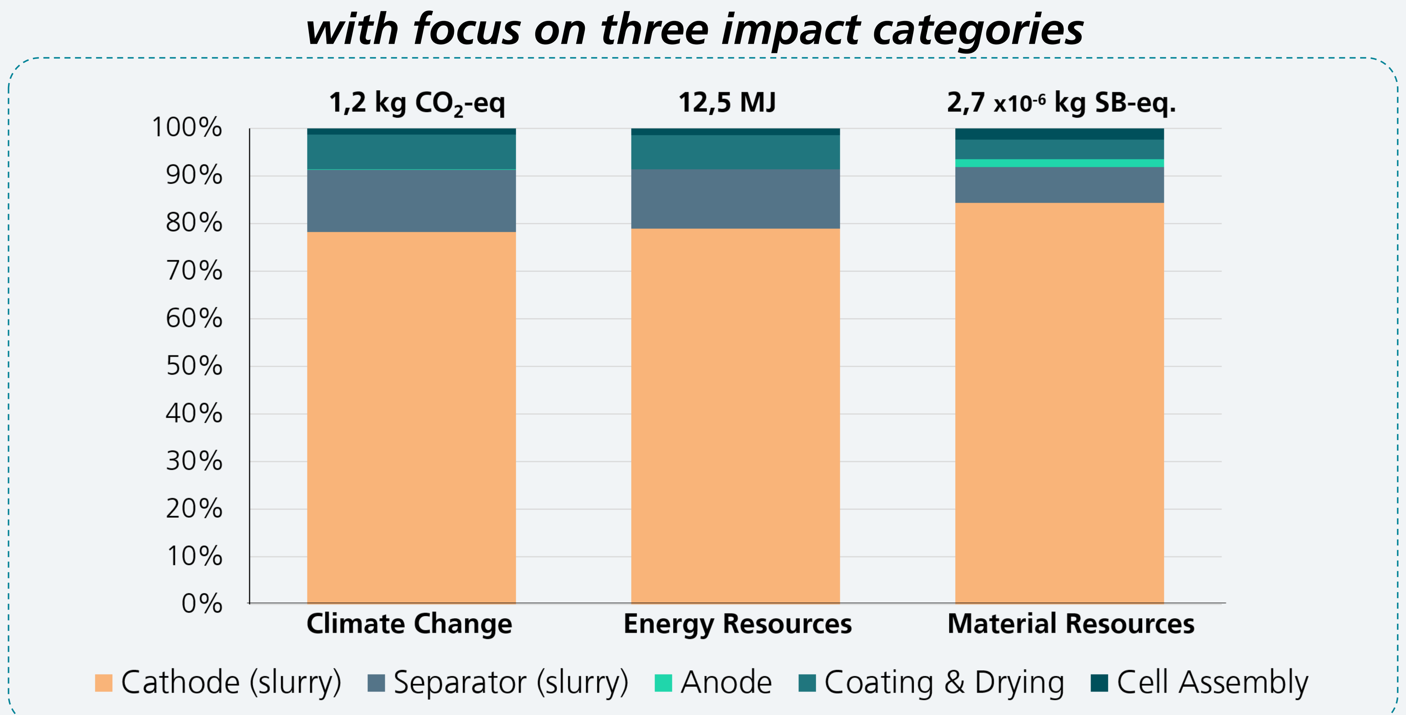


Bill of materials within the assessed sulfide-based process chain

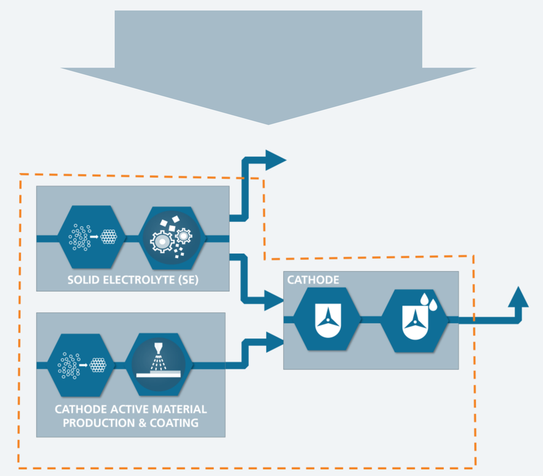
Component	Used Material
Current Collector (An)	Copper
Anode	Li-metal
Separator	Li_6PS_5Cl + HNBR
Cathode	NCM 811 + $LiNbO_3$ + Li_6PS_5Cl + C65 + HNBR
Current Collector (Cat)	Aluminium
Current Collector Tabs	Ni + Al
Housing	Pouch Foil

I. ENVIRONMENTAL RESULTS | SULFIDE ROUTE

Life Cycle Impact Assessment of the sulfide-based process chain with focus on three impact categories

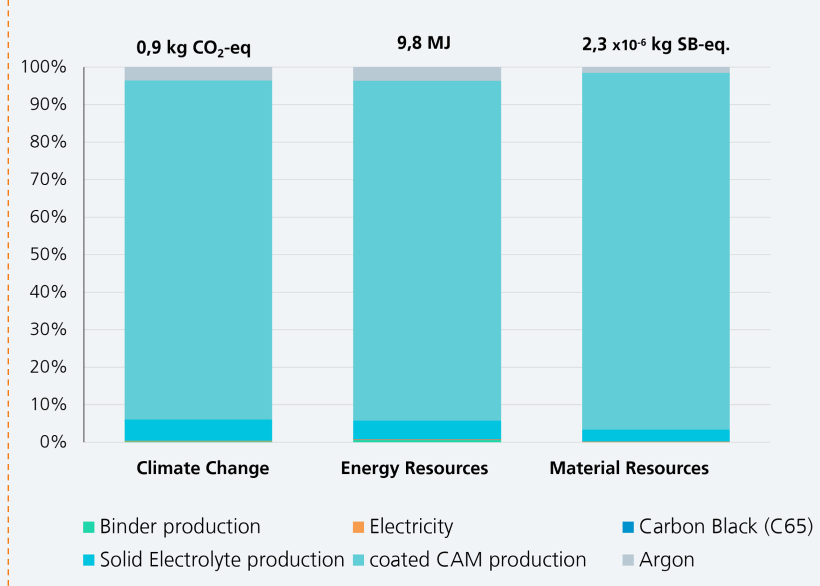


Main driver of environmental impacts: Cathode slurry manufacturing



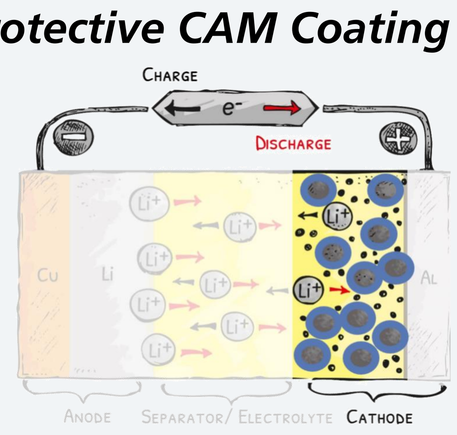
More than **90%** of environmental impacts caused by Cathode Active Material **(CAM) production & coating**

Life Cycle Impact Assessment of the Cathode slurry production



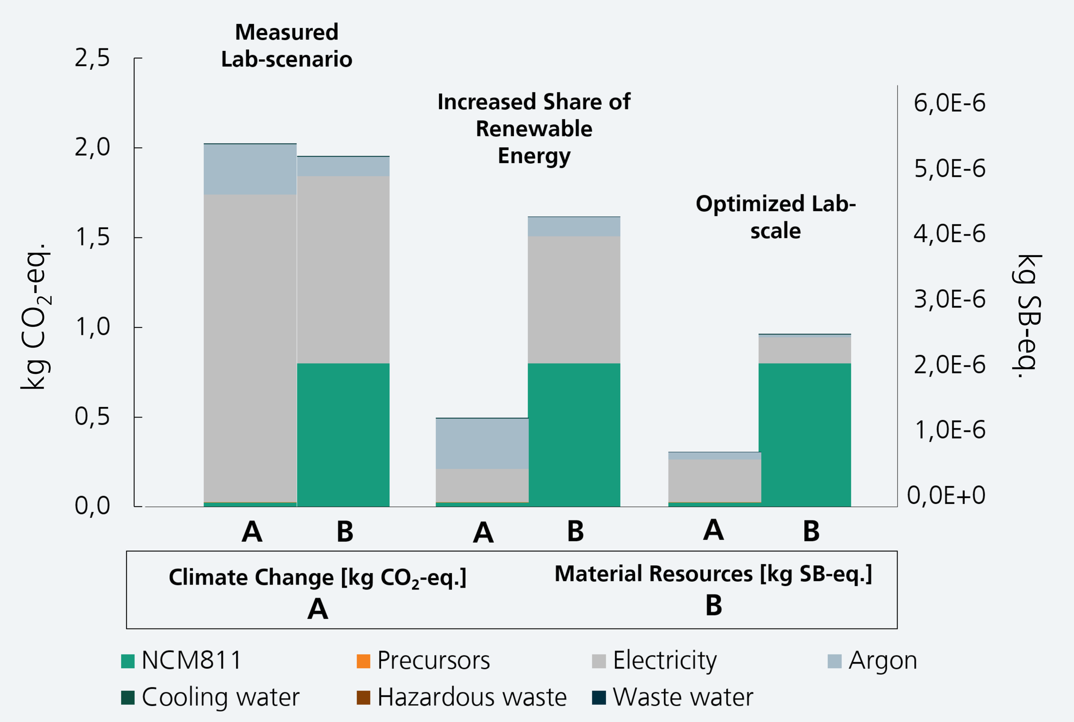
II. ENVIRONMENTAL RESULTS | CAM COATING

Protective CAM Coating



- Promising for improving cell performance by **avoiding SE degradation**
- Use of **Thermal Atomic Layer Deposition (ALD)** as a dry coating method, promising as a scalable process

Scenario Analysis of ALD CAM Coating process
(Reference Flow: Coating 1g NCM811 with $LiNbO_3$)



➡ The impacts caused by energy and argon consumption can be reduced

OUTLOOK

Deep dive into LCAs enables identification of hotspots and main levers for optimization ➡ Can contribute to setting focus for further research:

- Extending scenario analysis for more process steps
- Comparison of different material and process routes
- Investigation in scalability of the production processes and their environmental evaluation

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