Technische Universität Braunschweig
Institut für Automobilwirtschaft und Industrielle Produktion

LCM 2021

Recirculation of battery raw materials – the effects of allocation within a Life Cycle Sustainability Assessment approach

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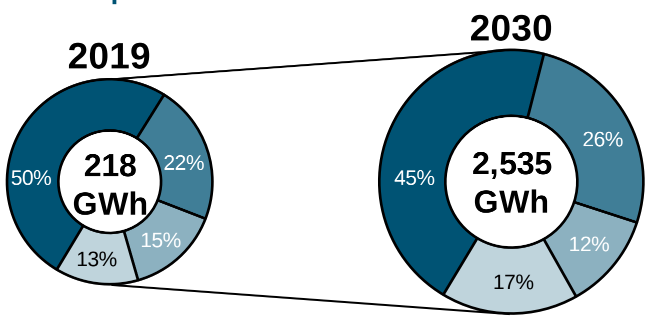
Current situation

LIBs placed in 2019 and forecast for 2030

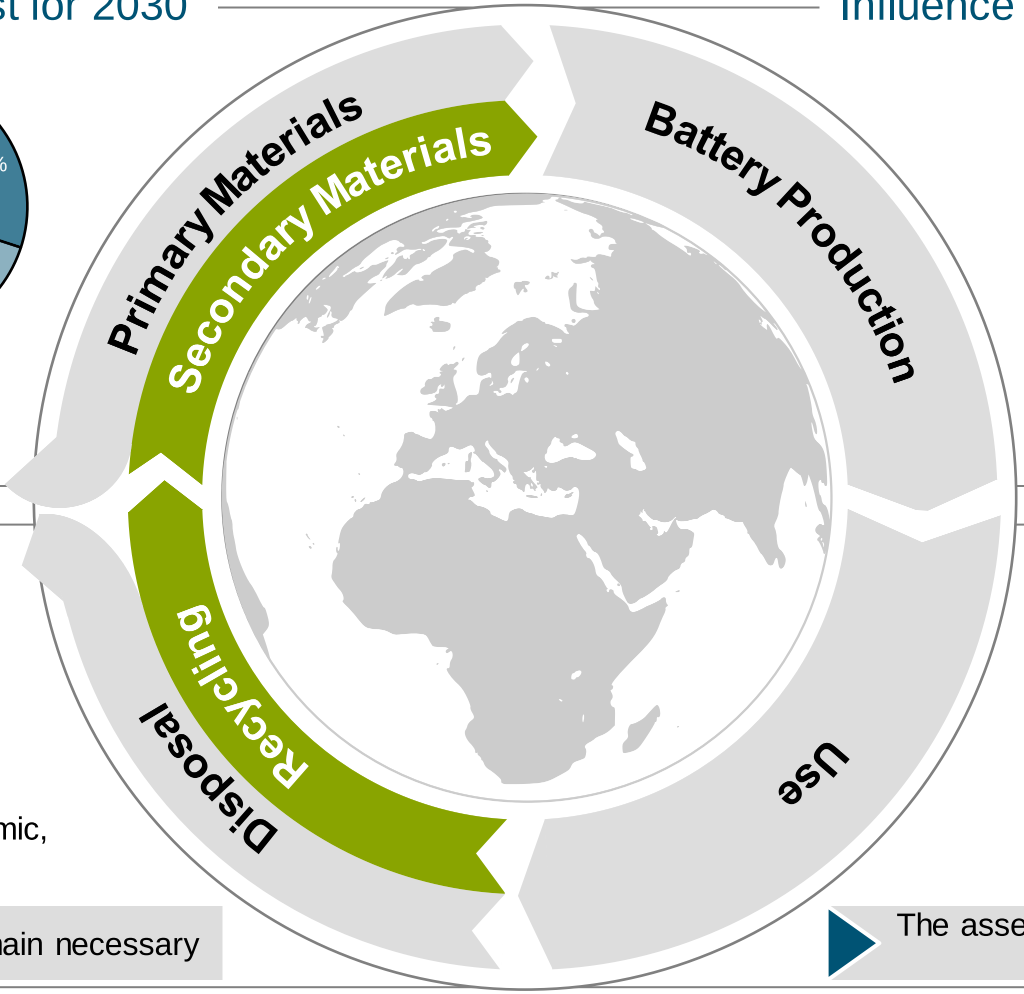


▶ Rising demand for raw materials and production capacities

Influence of raw materials on supply chains

- High economic dependency
- Environmental concerns
- Social concerns

▶ Safe and clean access to the required materials is necessary

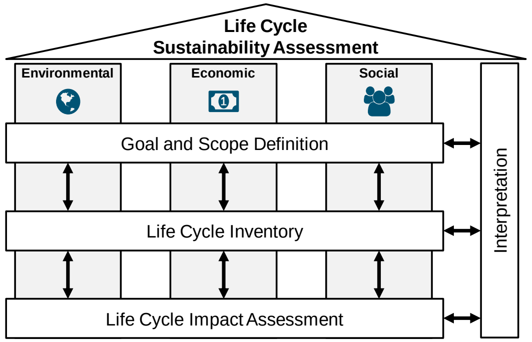


Closing the loop

- Recycling and the use of secondary materials is politically demanded
- Recycling enables a new source of supply
- Opportunity to reduce the economic, environmental, and social risks

▶ Assessment of the complete supply chain necessary

Sustainability assessment



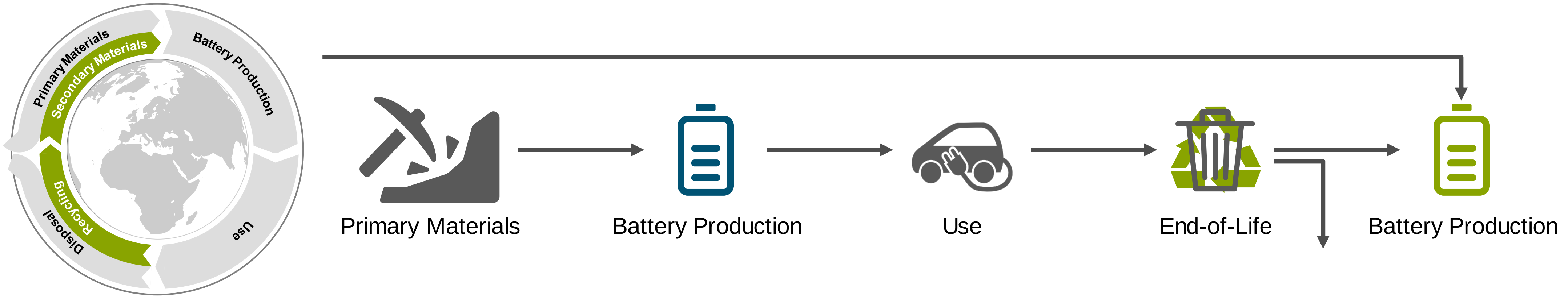
▶ The assessment of closed-loop supply chains leads to methodological challenges

[European Commission 2020; Melin et al. 2021]

LIB: Lithium-ion battery; RoW: Rest of World; LCSA: Life Cycle Sustainability Assessment

Allocation problem

System Boundary



Challenges and Objective

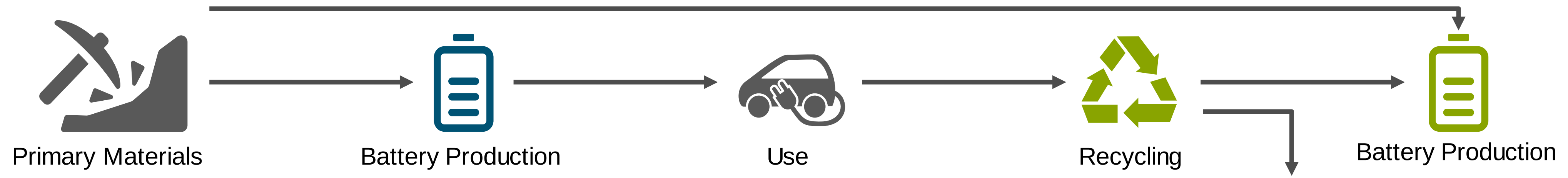
The impacts of the recycling processes must be allocated to the different battery systems

- Current allocation rules are mainly defined for the environmental assessment
- Battery supply chains should be assessed in terms of their environmental, economic, and social impacts
- The effects of current allocation rules on the LCSA approach are not analyzed in detail

Analyzing the effects of allocation rules in an LCSA in the context of battery supply chains

Definition

System Boundary



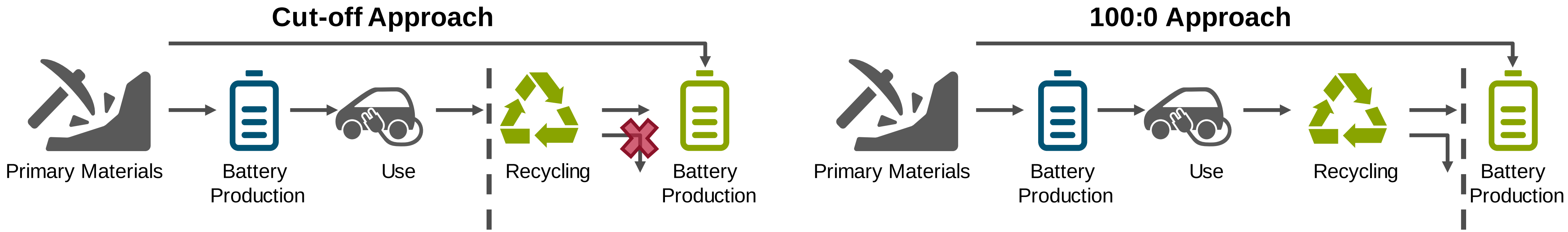
Impact Categories

Environmental
Climate Change

Economic
Value Added

Social
Risk of Child Labor

Allocation Rules



Criterion 1: Are the allocation rules usable from a methodological perspective?

Criterion 2: Are the results usable to give recommendations for the design of battery supply chains?

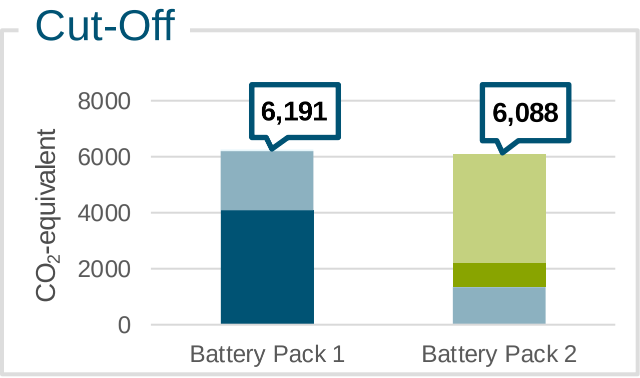
[Nordelöf et al. 2019; Ekvall et al. 2020]

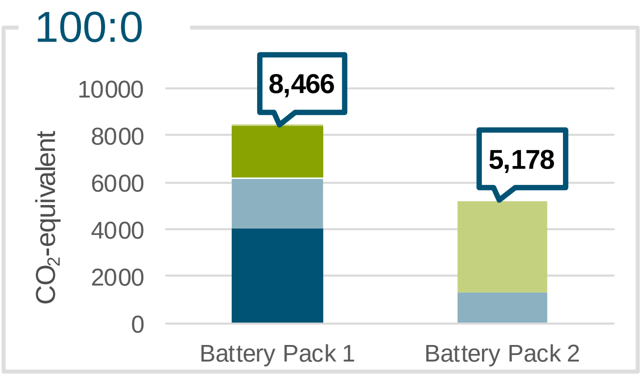
Case study
Results

Criterion 1: Results generated?

Criterion 2: Results usable?

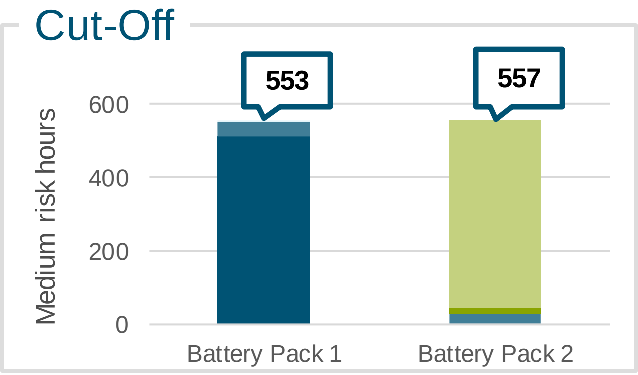
Climate Change

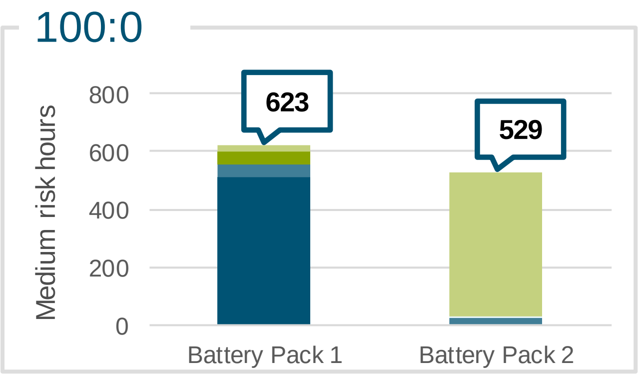




Criterion 1 ✔ **Criterion 2** ◑

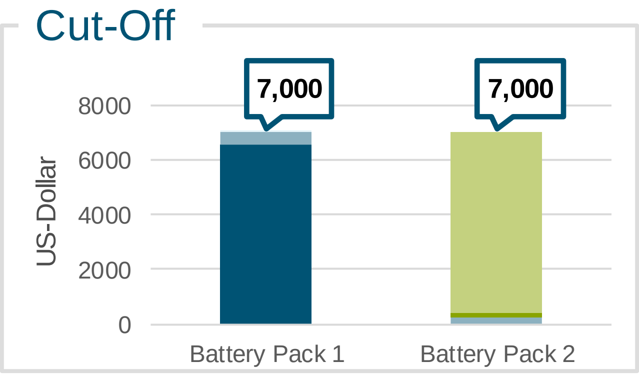
Risk of Child Labor

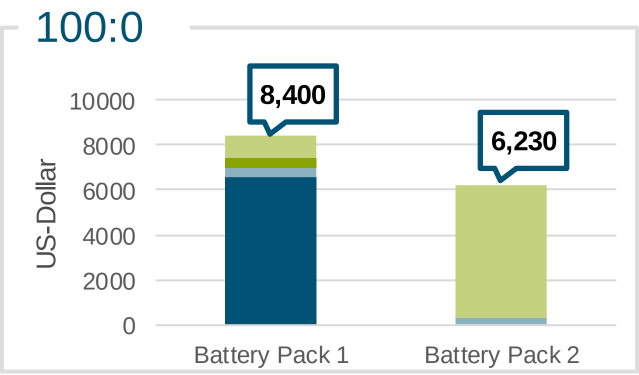




Criterion 1 ✔ **Criterion 2** ◑

Value Added



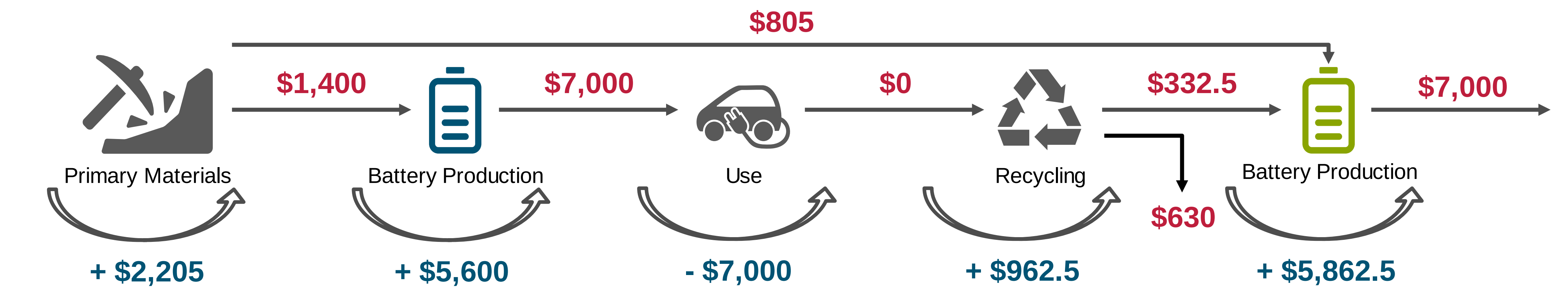


Criterion 1 ✔ **Criterion 2** ✘

Battery pack 1, production | Aluminum, primary | Lithium, primary | Battery pack 1, recycling | Battery pack 2, production

Evaluation

- Life cycle costs are the sum of the **value added** of each activity, i.e., the difference between the cost of the output and the cost of the intermediate product (**blue color**)
- The **price** of a product output is equal to the sum of the value added summed over all the upstream activities, including the value added of the activity itself (**red color**)



[Moreau and Weidema 2015]

- The Cut-off approach does not reflect the price of the secondary material, which is not used
- The 100:0 approach does not reflect the price of the batteries
- New approaches are necessary to evaluate battery supply chains within an LCSA

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Outlook

Outlook

- Development of new approach, which satisfy the criteria
- Assessment of battery supply chains
- Design of battery supply chains

Thanks for your attention!

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References

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