THE RESOURCE POTENTIALS OF CIRCULAR LOOPS: A CASE STUDY OF BATTERIES IN THE MINING SECTOR

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The circular economy (CE) is seen as a key concept for reducing environmental pressures and bringing forth more sustainable production and consumption practices (Geissdoerfer et al., 2017). To plan for and enable CE solutions, such as reuse and recycling strategies, it is critical to have knowledge of the future demand of products and materials, and how this matches the future supply of secondary sources. The timing, quantity, and geographical spread of resource flows determine the feasibility of CE solutions. To ensure that resource use is optimized it is important to have knowledge of these dynamics over time. Here, we use dynamic stock and flow (DSF) modelling to analyze the potentials of circular product and material flows at the company level, using lithium-ion batteries (LiBs) in the underground mining (UGM) sector as a case study. The case study is a company that sells battery driven UGM equipment and provides LiBs as a service. The LiBs are modular, can be set up in different configurations, and be used in several different machine types with varying energy capacity requirements. As a result, the LiBs can be given additional lifecycles (second, third, or fourth lives) in the different machines, before being recycled at end of life. The study is the first, to the authors knowledge, to use DSF modelling to analyze the resource-related effects of implementing a CE solution at the company level. The results are specific to the sector but also point to more generalizable insights about opportunities and limitations of the CE from a resource perspective.

We build on previous work by e.g. Müller (2006), and have further developed a DSF model that calculates the inflows, outflows, and stocks of LiBs by time, age-cohort, reuse-stage, application type, mining method used, and geographical market. The total demand for machines has been determined using data on ore production, mining methods, and future projections for primary material demand for the period 2020-2050. A number of scenarios for the potential future diffusion of batteries within the sector have been defined.

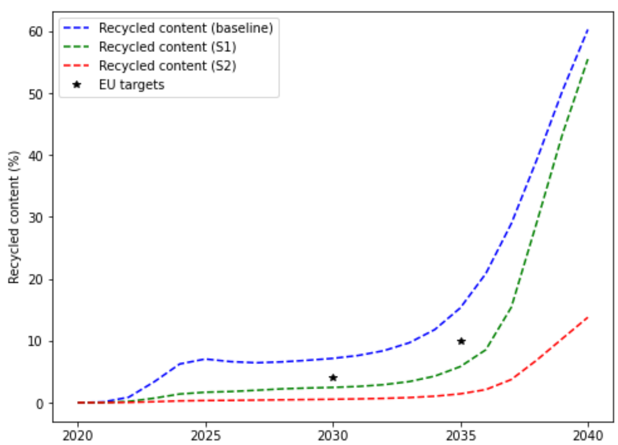

Figure 1 – potential recycled content of lithium in batteries for three scenarios

Preliminary results show that implementation of additional use cycles have the potential to reduce total resource use by approximately 20%, depending on the scenario. Variations in expected battery uptake in different markets, and differences in machine demand due to local conditions, impact the potentials for circular loops. The additional use cycles for the LiBs reduce the closed-loop recycled content for key materials like cobalt and lithium, potentially below EU recycled content targets (Figure 1). This illustrates the tension between reuse and recycling strategies. The results can be integrated with a prospective environmental life cycle assessment (LCA) to analyze the potential environmental benefits of reusing LiBs. The dynamics over time of, e.g. age-cohorts, reuse stages, and the regional markets where the LiBs are used will influence the potential environmental benefits of this type of solution. Combining DSF modelling with LCA will be an important tool for assessing the resource and environmental potentials of CE solutions.

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