Repair or replace? Guidance from indicators and life cycle assessment on circular economy strategies for energy-using products

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ABSTRACT

Various circular economy (CE) strategies, such as use extension with repair or reuse, have been suggested as a means for addressing the increasing resource and environmental footprint of society. To identify effective CE strategies, companies or policy makers seek guidance from the evaluation of resource use and environmental impact of alternatives that introduce different CE strategies to product systems. CE indicators and life cycle assessment (LCA) have been used for that purpose. However, a clear description of the differences between these two assessment methods as well as of the aspects accounted for by CE indicators is still missing. Therefore, the aim of this licentiate thesis is to advance the description of CE indicators and LCA in order to provide recommendations for practitioners to select the appropriate assessment method for their specific assessment goal.

To this end, LCA and CE indicators are compared by considering the type of results generated and the modelling specifications. Specific attention is given to the assessment of use extension of energy using products (EuP). This comparison builds on two studies: a review and analysis of CE indicators which identify the flows and processes that indicators account for and how indicators' and LCA results differ, and an LCA of the repair of a long-lived and energy intensive product which identifies what aspects are important to consider in the assessment of this overlooked product category.

The comparison shows that the two assessment methods provide different types of results. CE indicators inform on variations of resource use and especially on variations that are relative to other flows in the product system. LCA provides information on the environmental impacts and thus makes it possible to identify trade-offs between different types of environmental impacts. Besides, LCA allows a greater flexibility than CE indicators in capturing flows and processes but requires an extensive data collection. In comparison, CE indicators, and especially indicators focusing on one CE strategy at a time, have the advantage of being more time-efficient and of providing a detailed description of variations in resource use.

For assessing the reuse or repair of EuP, CE indicators are more limited than LCA with regards to ensuring that important changes in resource use are not missed. No indicator accounts for resource use in the use phase, and thus for changes in energy efficiency by design or with repair and for resources in energy production and transmission. These have however been found to be key aspects in the environmental performance of the repair of an energy intensive EuP.

Therefore, to decide on a repair or replacement, the selection of CE indicators and LCA as assessment methods depends on the type of impacts that a practitioner wants to base its decision on (e.g., environmental impact and/or resource use) and on the important modelling specifications for the product system (e.g., resources in energy production and transmission for the repair of an energy intensive EuP). Further research could focus on understanding the needs from practitioners in specific contexts to develop the practicability of these recommendations and on exploring other central modelling aspects for use extension such as the product's lifetime.

Keywords: circular economy, environmental assessment, use extension, indicator, life cycle assessment