**Product Lifetime-Extending Interventions: Measuring Circular Economy Impact**

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**Small loop circularity**

Circular Economy: “... industrial economy that is restorative or regenerative by intention and design” (Ellen MacArthur Foundation, 2013). Repairs (R3) is considered a “small loop” value retention option, providing high ecological value (Reike et al., 2018).

However, some repairs are very asset-intensive processes, requiring a functioning service supply chain.

- **“Right to repair” vs. planned obsolescence.**
- Value retention of repair becomes unclear: who benefits, who loses out, what is the effect on the circular economy?

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**Conventional repair** relies on static asset management: Large final batch of parts for spare parts when last equipment production orders; spare parts inventories limits how long equipment can be repaired

- Difficulty to forecast spare parts demand results in sub-optimal service level and costs

**Digitalized repair** (3D printed spare parts) enables more dynamic asset management: spare parts on demand; equipment can be repaired indefinitely

- “Right to repair” facilitated by dynamic (digital) assets.

However, from a Circular Economy perspective there are no indicators that readily captures the impact

- Material Circularity Indicator (MCI) measures how cyclical material flows are, not how efficiently product-lifetime extending interventions are
- Combination Metric (CM) considers both longevity (life-cycle) and circularity, but not cost
- Life-cycle Assessment (LCA) can account for all relevant differences, but requires extensive and detailed scenarios and information

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We need to develop circular economy indicators focused on repairs

- Current circular economy indicators are focused on large loops, such as recycling.
- Existing indicators lack capability in identifying important aspects, such as repairability and required assets (service supply chain).
- Previous research puts too little emphasis repairs in comparison to refurbishments.

We need to design economic incentives for manufacturers, in addition to giving users the “right to repair”

- Inherent conflict of interests between the manufacturer and the end customer related to repairs: regulation countering planned obsolescence circumvented by manufacturers.
- Economic mechanisms (similar to emissions trading) needed to align the interests of the manufacturer and the user

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Findings and further research

**Measurement challenge for product lifetime-extending interventions**

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Future research

- Heuristics for gained and lost value of interventions for repairs, right to repair, and countering planned obsolescence
- Role of regulation and economic incentives.