

# ARE THERMODYNAMIC BASED INDICATORS THE SOLUTION FOR ASSESSING CIRCULARITY OF NEW BUILDINGS?

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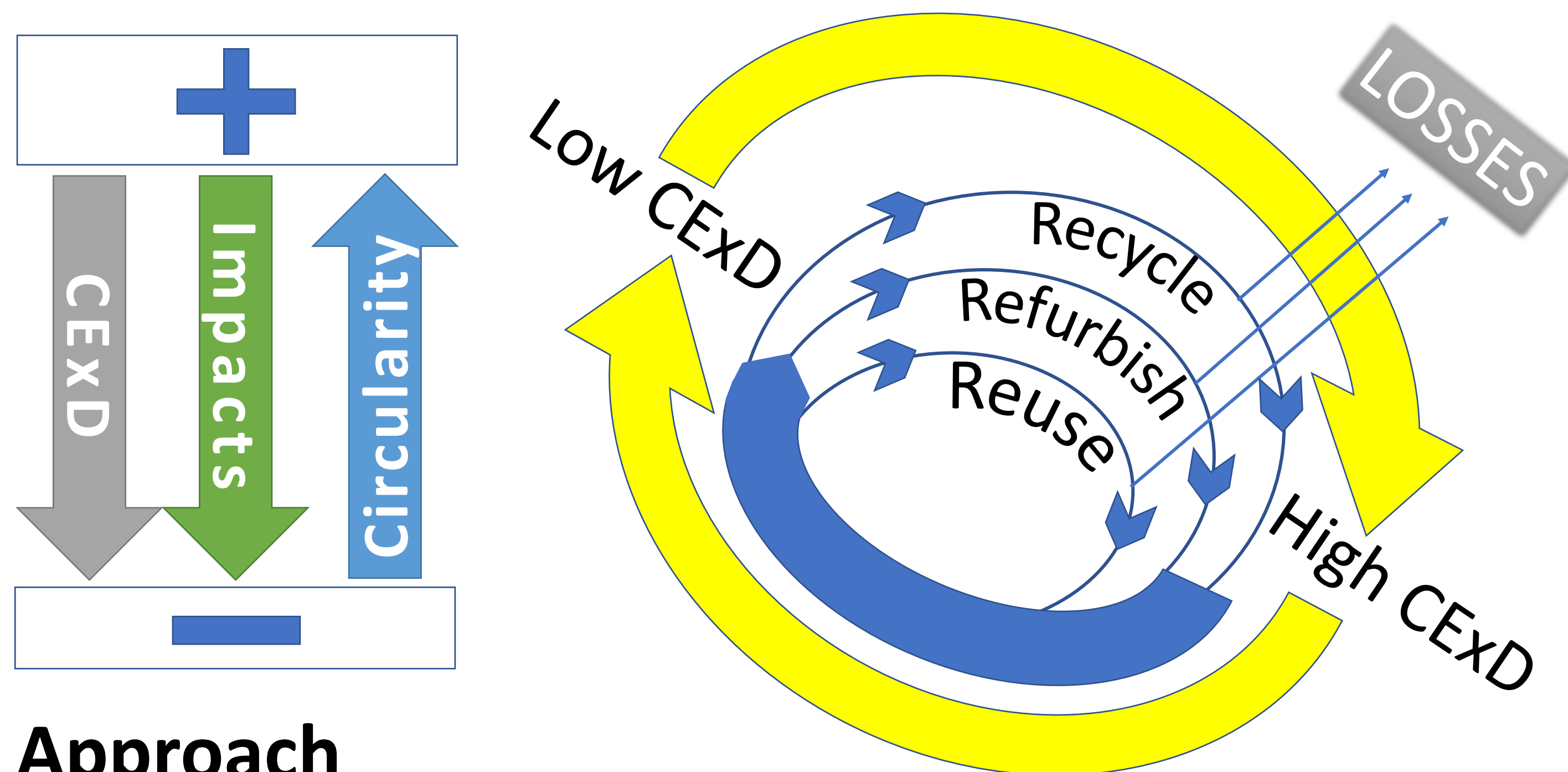
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## Problem setting

- To reach climate and circularity targets, infrastructure design tools have to take sustainability into account from the start and should facilitate the incorporation of secondary materials.
- Circularity indicators, like the material circularity indicator (MCI) are easy to calculate, but do not take into account energy demand or impacts. Thermodynamic indicators, like entropy or exergy comprise energy and materials, but are not easy to incorporate in an LCA analysis.

**Hypothesis:** Cumulative Exergy Demand (CExD) [high] = Impacts [high] = Circularity [low]



## Approach

### 1. Correlation CExD and LCA impacts?

For 6 construction materials: cement (portland and furnace slag), gravel, sand, water, steel.

### 2. Case study

Comparison of a concrete floor made of recycled (from demolition waste) and reused material (reclaimed concrete slab from building)

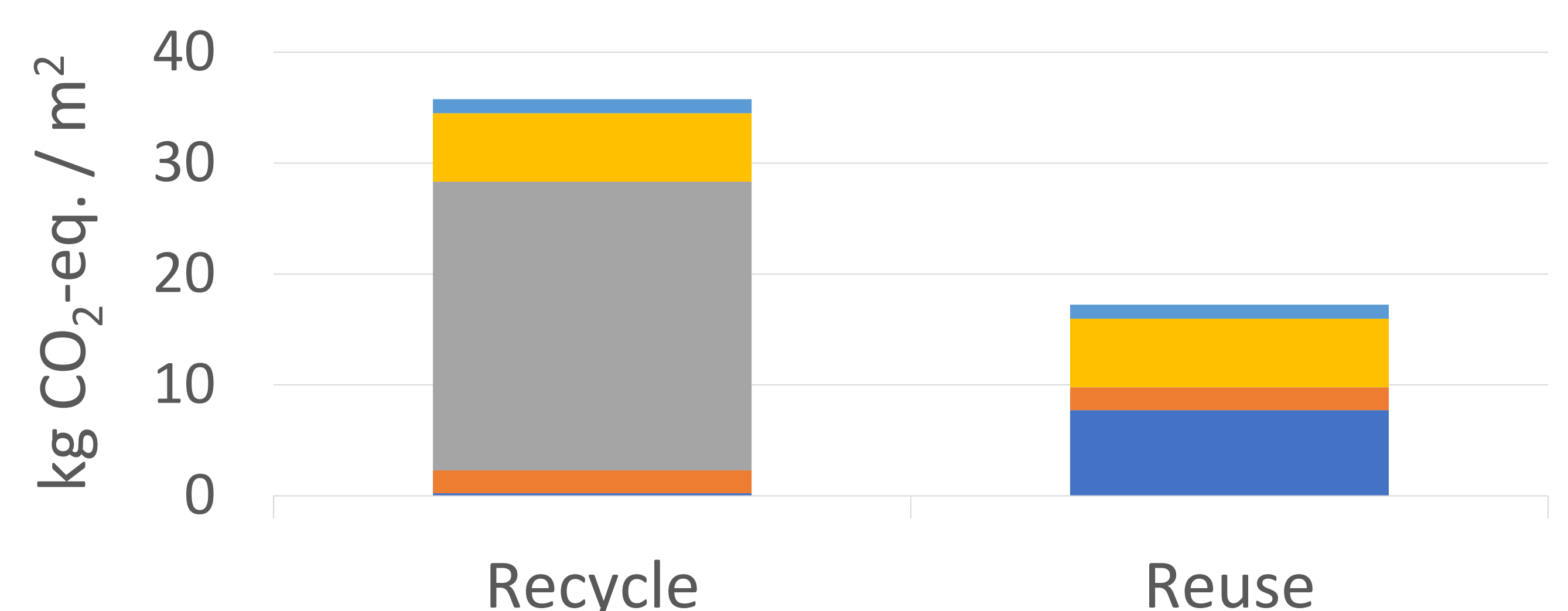
**Table 1.** Correlation between CExD and ReCiPe impact categories; MKI weighted results of 11 categories

	CExD
Global warming	R>0.9
Human toxicity	
Freshwater eutrophication	
Marine Ecotoxicity	
Land use	
Milieukostenindicator (MKI)	
Cumulative Energy demand	

Table 2. Comparison of cases	Recycle	Re-use
MKI (€)	4	2
GWP (kg CO <sub>2</sub> eq.)	36	19
MCI (%)	68	83
CExD (MJ)	254	142
CED (MJ)	229	127

## Results and discussion

- Several indicators show the same relation of the case scenarios (Table 2).
- The re-use case (shorter loop) had lower impact and CExD as well as a higher MCI, although the process of reclaiming materials had a higher impact (Figure 2).
- Energetic resources weigh heavier in comparison to materials in the final score



**Figure 2.** Comparison of CO<sub>2</sub> eq. emissions of recycled and reused floor. Light blue: construction; yellow: transport to construction site; grey: recycling/refurbishing; orange: transport to processing; dark blue: demolition/disassembly

**CExD indeed indicated lower impacts and preference for shorter loops**

## Conclusions

- Exergy is a useful resource use efficiency indicator for infra-structure systems.
- Material and energetic efficiency can be assessed jointly, presented separately and compared.

