Life cycle assessment of recycling and re-use of construction and demolition waste

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Life cycle

- Raw materials extraction
- Production
- Use
- Waste management

Resources:
- Energy
- Raw material
- Land

Emissions
- Waste
Raw material extraction → Material production → Production of products → Use → Landfill, Incineration, Energy use → Recycling → Collection → Alternative energy supply → Raw material extraction
Concrete -> Screed aggregate

1. Demolition and manual sorting of cellular concrete
2. Crushing of cellular concrete at Jacobs
3. Dry mixing of cellular concrete, cement and natural aggregate at Jacobs
4. Wet mixing at the construction site
5. Production of cement
6. Production of natural aggregate
7. Application of screed
Wood etc. →
→ Wood-polymer composite

WPC manufacturing

Plastic (HDPD)

Gypsum plaster boards
Wool insulation
Wood

Decking 1 m² (functional unit)
Three LCA approaches

- Screening LCA
- Hybrid LCA
- Consequential LCA
Concrete -> Screed aggregates
Screening results

- Conventional screed
- Recycled screed

% of Screening results:
- AP
- EP
- GWP
- ODP
- POCP
Concrete -> Screed aggregates
Screening GWP results

**Graph:**
- **Y-axis:** kg CO2-Equivalents
- **X-axis:** Cell. concr waste, Rec. concr. agg., River sand, Diesel, Wet mix screed, El., Cement, Tap water

- **Legend:**
  - Blue: Conventional screed
  - Red: Recycled screed
## Consequential LCA
(Weidema et al. 1999, Sköldberg & Unger 2008, Jelse et al. 2011)

<table>
<thead>
<tr>
<th>Marginal crude oil</th>
<th>Marginal natural gas</th>
<th>Marginal electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Worst” case:</td>
<td>“Worst” case:</td>
<td>“Worst” case:</td>
</tr>
<tr>
<td>Coal to liquid</td>
<td>Liquid natural gas</td>
<td>95% coal/oil,</td>
</tr>
<tr>
<td>“Best” case:</td>
<td>from Northern Africa</td>
<td>4% biomass</td>
</tr>
<tr>
<td></td>
<td>(e.g., Algeria)</td>
<td>“Best” case:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% coal/oil with CCS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29% wind</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20% natural gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7% coal/oil</td>
</tr>
</tbody>
</table>
## Input/output table

### Hypothetical extract

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Mining</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td></td>
<td>0</td>
<td>0.1</td>
<td>0</td>
<td>...</td>
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<tr>
<td>Manufacturing</td>
<td>Mining</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>...</td>
</tr>
<tr>
<td>Construction</td>
<td>Mining</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Hybrid LCA

Process tree + input/output table
• Tiered-hybrid approach
• IO-based hybrid approach
• Integrated hybrid approach
References


