BENCHMARK OF CIRCULARITY INDICATORS AND LINKS WITH LCA

Université Paris-Saclay, CentraleSupélec
EVEA
Agenda

1. Context and motivations
2. Objectives of the project
3. First results (ongoing project)
   - A knowledge base of 105 sets of circularity indicators
   - Classification and statistical analysis
   - Selection process of 10 c-indicators
   - Design of a c-indicators factsheet
4. Conclusion and perspectives
   - Link with LCA
   - Excel/Web-based tool
Motivations and challenges

Evaluation of the potential sustainable benefits from the circular economy (CE) transition

Integration and deployment within industrial practices

Clarification of their purpose, specificity, operationality

Increasing number of C-indicators: between utility and fuzziness

Need of methods and tools to assess and monitor circularity

100+ definitions of a CE (Kirchherr et al. 2017)

Circularity indicators (C-indicators) are defined here as a quantitative or qualitative factor or variable that provides a simple and reliable means (OECD, 2014) to assess and monitor the performance of systems (products, processes, services) in a circular economy perspective.
Objectives

1. State-of-the-art:
   - extended inventory
   - description
   - classification
   - critical analysis

2. Detailed analysis:
   - selection process/method
   - feedback from industry
   - c-indicators factsheet

3. Recommendations:
   - decision-making support
   - deployment (tools)
   - link with LCA

Scientific managers and Steering committee:
EVEA / CentraleSupélec
SCORELCA and members
A Systematic Literature Review identified 105 sets of circularity indicators from various sources:

- Academic database
- Grey literature
- Excel spreadsheet

![Excel spreadsheet screenshot](image-url)
C-indicators classification

- Augmentation of the initial taxonomy of 55 sets of C-indicators, in 10 categories

<table>
<thead>
<tr>
<th>Key CE principles</th>
<th>Purpose</th>
<th>Formalism</th>
<th>Validity criteria</th>
</tr>
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<tbody>
<tr>
<td>Implementation level</td>
<td>Circularity perspective</td>
<td>Units</td>
<td>Use case</td>
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<tr>
<td>CE loops</td>
<td>Usage (purpose)</td>
<td>Format (accessibility)</td>
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<td>Dimension</td>
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<td>CE sphere</td>
<td>Circularity performance</td>
<td>Source (developers)</td>
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10 initial categories + 5 new ones

= To cover the complexity of the circular economy

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= Applicability criteria for SCORELCA members
C-indicators classification

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### C-indicators classification

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#### Key CE principles

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#### Purpose

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#### Formalism

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</table>

#### Validity criteria

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<th>Use case</th>
<th>Popularity</th>
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**C-indicators classification**

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<tbody>
<tr>
<td>• Material / Product</td>
<td>• Maintenance</td>
<td>• Effective (retrospective)</td>
<td>• Impacts (effects)</td>
<td>• Quantitative</td>
</tr>
<tr>
<td>• Business / Activity</td>
<td>• Reuse/Reman</td>
<td>• Potential (prospective)</td>
<td>• Intrinsic (flow)</td>
<td>• Qualitative</td>
</tr>
<tr>
<td>• Region</td>
<td>• Recycling</td>
<td></td>
<td></td>
<td>• %, $, CO2</td>
</tr>
</tbody>
</table>

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<tr>
<td>• Multi-score</td>
<td>• Information</td>
<td>• Academic</td>
<td>• Generic</td>
<td>• Web-based</td>
</tr>
<tr>
<td>• Single score</td>
<td>• Decision-making</td>
<td>• Company</td>
<td>• Sector specific</td>
<td>• Excel-based</td>
</tr>
<tr>
<td></td>
<td>• Communication</td>
<td>• Organization (env., pol.)</td>
<td></td>
<td>• Formulas to compute</td>
</tr>
<tr>
<td></td>
<td>• Education</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CE sphere**

- • Technosphere
- • Biosphere

**Life cycle stages**

- • Design
- • Manufacturing
- • Use
- • End-of-life

**Use case**

- • Yes
- • No
- • Link

**Popularity**

- • Acknowledged
- • Intermediary
- • Marginal

**Transparency**

- • Formulas available
- • Black box

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C-indicators: statistical analysis (first results)

Publication years:

- 2020
- 2018
- 2016
- 2014
- 2012
- 2010

Number of C-indicators sets

CE implementation levels:
- Micro: 43
- Meso: 31
- Macro: 41

Sectors of development:
- Academics (scholars, universities)
- Organizations (environmental, governmental)
- Companies (industrial, consulting)
C-indicators: statistical analysis (ongoing)

- Number of unique c-indicators
- Overlapping
- Sustainability coverage
- ...

C-indicators selection process, by expert (draft)
C-indicators selection process, by tool

- Same working principle as an expert system

"An expert system is a computer-based system that emulates, or acts in all respects, with the decision-making capabilities of a human expert" Prof. Feigenbaum, Stanford University

Inputs = 8 queries

C-level
C-perspective
C-performance
C-loops
...
C-format

The C-Indicators Advisor

C-indicator(s) name
Working principle
...

Outputs = 10 key info on the C-ind(s) selected

Internet access link
C-indicators Advisor: Excel and Web-based tools

http://www.circulareconomyindicators.com/
C-indicators selection w/ SCORELCA partners

- 30-minute interview
- C-Indicators Advisor

Once the DB is updated, recommendation of specific c-indicators
C-indicators factsheet (FR)

- Design of a new indicator card
- Application to the MCI

Material Circularity Indicator (MCI)
Indicateur de circularité matériau

**Source:** Fondation Ellen MacArthur et EIT RawMaterials, 2015

**Présentation**
- **MCI** combines the aspects of quantity and intensity of use with the proportion of content recycled and the proportion of material recycled in a product or a service, unique, applicable to the product or to the activity of an enterprise. It goes beyond the linear phase of production and consumption. Measures taken like circular mass are maximized and the circular mass flow is minimized.

**MCI** is a value between 0 and 1, where 1 indicates the highest level of circularity.

**Le MCI a pour objectifs:**
- To develop new indicators on materials/products.
- To support sustainable raw materials inventories, as well as and in such measures.

**Expression et calcul**

\[
MCI = 1 - \frac{V + W}{2M + Wf - Wc} 0.9X
\]

**Finalité de l’indicateur**

Perspective de production:
- Effective (économe)
- Performance (productivité)

Usages (destination):
- Fournisseur
- Type de recouvrement
- Communication

Transparence de l’appréciation:
- Général
- Spécifique secteur

Performance évaluée:
- Impact (éco)
- Intensité (fluide)

**Périmètre de l’économie circulaire couvert**

- Matière / Produit
- Organisation / Activité
- Territoire

- Maintenance & durabilité
- Réemploi / réutilisation
- Recyclage

- Conception
- Production
- Utilisation
- Fin de vie

**Mise en perspective de l’indicateur**

Le MCI fait partie des indicateurs circulaires permettant de calculer en un seul temps la performance circulaire d’une entreprise.

Le projet de recherche est en train de travailler sur la prise en compte dans le MCI des matériaux biocarburés, en admettant notamment les défis liés aux matériaux combinant biocarburé et technique, ainsi que des réalités permettant d’évaluer les risques complémentaires liés aux matériaux biomarqués.

**Crédits:** CentraleSupélec & EIT RawMaterials for ScoreLCA – 2021
C-indicators factsheet (EN)

- Design of a new indicator card
- Application to the MCI

Material Circularity Indicator (MCI)

**Source:** Ellen MacArthur Foundation and Granta Design, 2015

**Presentation**

The Material Circularity Indicator (MCI) for a product measures the extent to which linear flow has been minimized and resource flow maximized for its component materials, and how long and intensely it is used compared to a similar industry-average product.

The MCI measures the level of circularity in the range 0 to 1, where higher values indicate a higher circularity.

The MCI has two main objectives:

- Compare different solutions of materials/products
- To know on which natural resources are dependent and in what extent

**Expression of calculation**

Material Circularity Indicator (MCI) = \( 1 - \frac{V + W}{2M + W/2 - WC} \times 0.9X \)

**General expression (automatic calculation following parameters to be filled)**

The indicator is calculated thanks to an Excel tool, available on free download: [https://www.ellenmacarthurfoundation.org/our-works/material-circularity-indicator](https://www.ellenmacarthurfoundation.org/our-works/material-circularity-indicator)

**Calculation parameters to be filled**

<table>
<thead>
<tr>
<th>Feedback</th>
<th>MCI calculation</th>
<th>Destination after use</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Reused</td>
<td>Reused content rate</td>
<td>Reusable content rate</td>
</tr>
<tr>
<td>% Recycled</td>
<td>Recycled content rate</td>
<td>Recyclable content rate</td>
</tr>
<tr>
<td>Recycling efficiency</td>
<td>Loss rate during recycling</td>
<td>Loss rate during end of life recycling</td>
</tr>
<tr>
<td>Lifespan</td>
<td>Lifecycle compared to industry average</td>
<td>Fill one of these two parameters</td>
</tr>
<tr>
<td>Functional units</td>
<td>Number of units used compared to industry average</td>
<td></td>
</tr>
</tbody>
</table>

**Data input**

A detailed list of materials for the product is needed to compute the MCI, and more specifically:

- Input in the production process: How much input is coming from virgin and recycled materials and reused components?
- Utility during use phase: How long and intensely is the product used compared to an industry average product of similar type?
- Take into account increased durability of products, but also repair / maintenance and shared consumption business models?
- Destination after use: How much material goes into landfill (or energy recovery), how much is collected for recycling, which components are collected for reuse?
- Efficiency of recycling: How efficient are the recycling processes used to produce recycled input and to recycle material after use?

**Purpose of the indicator**

- **Circularity perspective**
  - Actual (retrospective)
  - Potential (perspective)
- **Use (destination)**
  - Information
  - Decision making
  - Communication
  - Education
- **Transparency of the application**
  - Design
  - Sector specific
  - Education
- **Performance evaluated**
  -高峰 / efficiency
  - Internal (flows)

**Perimeter of circular economy covered**

- Implementation level
  - Material / product
  - Organization / activity
  - Territory
- Size of the loop
  - Maintain
  - Dispose
  - Remanufactured
  - Derelict
- Life cycle stages
  - Design
  - Production
  - Use
  - End of life
- Sectors of similar economy concentrated
  - Technology
  - Environment
  - Both

**Forecasting**

The MCI is part of Circulytics, which provides a single score on a company level to describe a company’s circularity. The co-project group is expanding the MCI methodology to include biological materials and addressed some of the challenges associated with combinations of biological and technical materials. This group is also addressing some of the risk-oriented complementary metrics for biological materials.

**Credits:** CentraleSupélec & EWEA for Score, LA – 2021
Perspectives: link with LCA

On peut a priori imaginer 3 pistes à explorer sur les liens ACV/indicateurs de circularité :

1. Les données de sortie de l’ACV (flux/mid/endpoints) sont utilisées comme données d’entrée pour le calcul d’indicateurs de circularité ;

2. Un/des indicateurs de circularité sont intégrés en données de sortie de l’ACV sous forme d’indicateur flux midpoint/endpoint/ ;

3. L’ACV est utilisée pour vérifier le bien fondé d’un jeu d’indicateurs de circularité (à valider sur produits connus, gagner du temps vs. ACV)
Related SCORELCA work


And now:
- SCORELCA. 2021. Benchmark of circularity indicators and links with LCA. Study Nº 2020-03.
BENCHMARK OF CIRCULARITY INDICATORS AND LINKS WITH LCA

Questions?
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