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## Circularity Indicators: the Advisor

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► **To cite this version:**

Michael Saidani, Bernard Yannou, Yann Leroy, François Cluzel. Circularity Indicators: the Advisor. ASME 2018 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE 2018, Aug 2018, Québec, Canada. hal-01790126

**HAL Id: hal-01790126**

**<https://hal.science/hal-01790126>**

Submitted on 14 Dec 2018

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## CIRCULARITY INDICATORS: THE ADVISOR

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### Key words:

Circular economy, circularity indicators, taxonomy, selection tool.

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Context: Moving towards circular design, industrial and business practices is increasingly encouraged in a context of sustainable development [1]. Following a common agreement - shared by academics, industrialists and politics - on the need to provide circular economy related indicators at different systemic levels to facilitate and monitor this transition, many circularity tools, metrics, and indicators have been developed in the last few years [2]. In fact, design for circularity is an emerging field that needs new integrated frameworks, including tools and indicators, to help establishing innovative solutions across sectors in line with the circular economy paradigm [3]. Yet without a stabilized definition of what circular economy is, it is of the utmost importance to know what available indicators measure in order to use them properly. More than 50 sets of circularity indicators – created and used by scholars, consulting companies and governmental agencies worldwide – have been reviewed and classified (see Figure 2) into a need-based taxonomy driven by the usage of such indicators.

Description of the tool: A query tool (simplified search tool, see Figure 1) associated to the proposed taxonomy databank – using MS Excel with macros – has been designed to help identifying the most relevant tool(s)/indicator(s) regarding the user needs. It aims thus at clarifying the purpose of – and at characterizing – each indicator according to suitable criteria in line with circular economy paradigm and features. In inputs (see Figure 3), eight questions are asked to direct the users towards the most suitable indicator(s) and related assessment framework. Selection criteria are the following: i) scale of measurement; ii) circularity perspective; iii) circularity performance; iv) circularity loop; v) dimensionality; vi) usages and purposes; vii) transversality; viii) type and format. In outputs, appropriate indicator(s) are identified and following information is displayed: a) tool/indicator name; b) working principle; c) details about the systemic level; d) details about the kinds of circularity; e) details about the dimensionality and unit; f) data required to compute the tool/indicator; g) possible usages; h) authors and references; j) internet access link.

Proposed display experience: **Demonstration:** The tool is first presented through an industrial example of a company willing to measure, improve and monitor the circularity performance of a product – a catalytic converter – that the company designed and developed. Based on the company's needs and requirements, results propose several potentially useful circularity indicators and associated calculation methods, frameworks, or tools at a micro level – the one of products and materials – which aim at (i) evaluating circularity potential of industrial products during design and development process, (ii) providing guidelines for circular design improvement, (iii) facilitating benchmarking with competing products. As a candidate set of circularity indicators, a second version of a digital tool presented at ICED17 [4], aiming at enhancing product circularity potential performance during design or re-design phases is used. **Experimentation:** Participants have two possible options: (1) Participants may test and experience the selection tool on their own projects to find out which circularity indicators suit the best to their need. It is possible for them to work individually (or in small group) on their own project or case study linked to the circular economy. As such, they are proposed to experience, and feed the query tool with their requirements so as to identify indicators that might be relevant for them. Then, as access links are provided to explore

the recommended indicators in output – including associated working principle and calculation methods – attendees are free to test such circularity indicators. (2) For participants who do not have a particular case study or sufficient data to experience the tool by their own, but who are interested in testing the query tool and recommended indicators, it is possible to operate the data from the catalytic converter example to do so. A synthesized two-page plasticized datasheet is provided to get enough information and knowledge on the industrial environment and product to feed the tool and to experience various circularity indicators. For all, a response document template is given to participants who want to keep track of their findings or provide feedbacks on the tool.

For information, this circularity indicators query tool is flexible in the way the databank is not frozen and may be easily updated. As such, it is possible and highly appreciated for attendees to contribute in return to the tool development or consolidation, e.g. if participants are aware of – have tested, or are developing – new circular economy related tools and indicators that are not inventoried in the actual databank.

Audience: This tool seeker aims to guide designers, engineers, researchers, managers, administrators, decision-makers, policy-makers, etc., in identifying and selecting the most suitable(s) tool(s)/indicator(s) to assess, improve and/or monitor their circular practices according to their specific needs and requirements. But it is open to everyone (novice or expert) interested in circular design and life cycle thinking, in order to discover the possible contributions of circularity indicators and how they can be used in practice.

List of what would be needed for the display: Station with computers (including Microsoft Excel with macros enabled). Plasticized datasheet will be provided by our own.

Minimum area: No special needs, just enough room for tables, chairs, and computers, close to power outlets if possible.

Internet connection: Yes, ideally so that participants can experience the tool and indicators on their own computers – if not, the tool and some indicators experimented could be stored and made available in a USB key.


Other supplies or utilities: Microsoft Windows and Microsoft Excel with macros are required to use and run the query tool.

#### References:

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- [3] Earley, R. 2017. Circular Design Futures. *The Design Journal*, 20:4, 421-434, doi: 10.1080/14606925.2017.1328164
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## APPENDIX A - ILLUSTRATIONS OF THE TOOL

Figure 1: Snapshot of the tool and overview of some circularity indicators



**Circularity Indicators \_ The Advisor**  
*Target the Right Indicators for Your Organization*

**Presentation**



Circularity Indicators  
- The Search Engine  
- The Query Tool

↑↑↑↑↑↑↑↑

*This tool seeker aims to guide designers, engineers, researchers, managers, administrators, decision-makers, policy-makers, etc., in identifying and selecting the most suitable tool(s)/indicator(s) to assess, improve and/or monitor their circular practices according to their specific needs and requirements.*

According to a common agreement - shared by academics, industrialists and politics - on the need to develop circular economy (CE) related indicators, many tools, index, metrics, indicators have been designed. Yet without a standardized definition of what circular economy is, it is of the utmost importance to know what these indicators measure in order to use them properly, within the both fuzzy and complex concept of CE. As such, this taxonomy - in which the tool seeker will help out identifying most suitable tool(s)/indicator(s) - aims at clarifying the purpose of and at characterizing each indicator according to relevant criteria in line with circular economy paradigm and features.

**In inputs**, several questions to oriente you towards the most suitable tool(s)/indicator(s), will be asked about:

- i) scale of measurement; ii) circularity perspective; iii) circularity performance; iv) circularity loop; vi) dimensionality; v) usages and purposes; vii) transversality, viii) type and format.

**In outputs**, one or several tool(s)/indicator(s) will be identified and following information will be displayed:

- i) tool/indicator name; ii) working principle; iii) details about systemic level (scale); iv) details about the kinds of circularity; v) details about the dimensionality and unit; vi) data required to compute the tool/indicator; vii) possible usages; viii) type of tool; ix) authors and references; x) internet access link.

→ → → **Click on the logo above or go directly to the Inputs tab below, to start your research** ← ← ←

*The present taxonomy of circularity indicators and the seeker tool have been developed by Michael Saidani during his PhD thesis at the Industrial Engineering Department of CentraleSupélec, Paris-Saclay University, under the supervision of Prof. Bernard Yannou, Assistant Prof. Yann Leroy and Assistant Prof. François Cluzel, funded by The French Ministry of Higher Education, Research and Innovation (Ministère de l'Enseignement Supérieur, de la Recherche, et de l'Innovation), and in collaboration with the Industrial Ecology Program at UC Davis, under the supervision of Prof. Alissa Kendall, thanks to the support of the Fulbright Commission.*

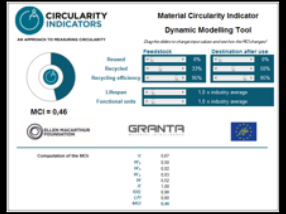







Figure 2: Databank associated to the taxonomy of circularity indicators (for information: it is integrated in the Excel tool but it will not be particularly displayed during the showcase)

Circularity Measurement Instrument/Tool Indicator Name (Author, Framework)	Definition/Approach/Working Principle (Input/Output)	Systemic Levels			Circularity Perspectives (Retro/Pro)		Circularity Performance (Impact/Resilience/Robustness)		Units/ID, & Ag. (Circular/Quadrant/Quadrant)	Diagrams (Single/Loop/Thicket)	Data (Systemic/Single/Loop/Thicket)	Usage/ Purpose - Decision-Making - Targeted Participants	Sources (Database)				Criteria of Type of Tools (Formal/Informal/Field)	Access Link		
		Micro	Meso	Macro	Actual (Efficient)	Potential	Impact (Effectiveness)	Resilience (Robustness)					Academic	Operational (Govt, Ind)	Comparative (Industrial)	Consulting (Agency)				
Ecological Footprint (EF) (Wackernagel, Rees)	Indicates for the overall human demand on natural resources.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Circular Economy Performance Indicator (CEPI) (European Commission)	Formally, the ratio of the material productivity in a given sector.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Resource Footprint Indicator (RFI) (European Commission)	The RFI indicates the total amount of natural resources used in a given sector.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Material Circularity Indicator (MCI) (European Commission)	The MCI is a fine-grained indicator of the circularity of a product.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Circularity Performance Index (CPI) (World Economic Forum)	The CPI is a fine-grained indicator of the circularity of a product.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Product Level Circularity Index (PLCI) (Wur)	The PLCI is a fine-grained indicator of the circularity of a product.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Business Level Circularity Index (BLCI) (Wur)	The BLCI is a fine-grained indicator of the circularity of a business.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Building Circularity Indicators (BCI) (Wur)	The BCI is a fine-grained indicator of the circularity of a building.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Urban Circularity Indicators (UCI) (Wur)	The UCI is a fine-grained indicator of the circularity of an urban area.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
National Circularity Indicators (NCI) (Wur)	The NCI is a fine-grained indicator of the circularity of a country.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Regional Circularity Indicators (RCI) (Wur)	The RCI is a fine-grained indicator of the circularity of a region.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Local Circularity Indicators (LCI) (Wur)	The LCI is a fine-grained indicator of the circularity of a local area.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Resource Footprint Indicator (RFI) (European Commission)	The RFI is a fine-grained indicator of the circularity of a product.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Circularity Performance Index (CPI) (World Economic Forum)	The CPI is a fine-grained indicator of the circularity of a product.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Product Level Circularity Index (PLCI) (Wur)	The PLCI is a fine-grained indicator of the circularity of a product.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Business Level Circularity Index (BLCI) (Wur)	The BLCI is a fine-grained indicator of the circularity of a business.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Building Circularity Indicators (BCI) (Wur)	The BCI is a fine-grained indicator of the circularity of a building.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Urban Circularity Indicators (UCI) (Wur)	The UCI is a fine-grained indicator of the circularity of an urban area.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
National Circularity Indicators (NCI) (Wur)	The NCI is a fine-grained indicator of the circularity of a country.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Regional Circularity Indicators (RCI) (Wur)	The RCI is a fine-grained indicator of the circularity of a region.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-
Local Circularity Indicators (LCI) (Wur)	The LCI is a fine-grained indicator of the circularity of a local area.	-	-	-	-	-	-	-	-	Quantitative (IC)	Multiple Indicators (Production, Emissions, Land Use)	Quantitative	P (Environmental)	-	-	-	-	-	-	-

Figure 3: Input data

 <b>Circularity Indicators _ The Advisor</b> <i>Target the Right Indicators for Your Organization</i>	<b>Inputs - Filtering</b> <b>Selection Criteria</b>
↑↑↑↑↑↑↑↑↑↑	
- Instruction -	
1/ <b>Fill in the yellow cells</b> that can be scrolled, as a filter to identify the most suitable circularity tool(s)/indicator(s) to your needs ↓↓↓ 2/ <b>Click on the logo above</b> to launch the search and have access to your personalised inventory of circularity tools/indicators. ↑↑↑ <i>N.B. You can leave one or several criteria blank to have access to a wider variety of proposed solutions.            For instance, if all criteria fields are left empty, every tool available among the inventory will be displayed.</i>	
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Scale of Measurement*</b> Are you focused on the circularity of products, components, materials (micro), of a company, organization, industrial symbiosis, eco-park, value chain (meso), of a region or nation (macro) ?	<b>Micro</b>
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Circularity Perspective (Retro- or Pro-)*</b> Are you interested in knowing actual and effective circularity performances (retrospective) or potential performances of circular practices e.g. during product development (prospective) ?	<b>Potential</b>
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Circularity Performance*</b> Are you willing to evaluate the intrinsic performance of your circularity loops (recirculation of resources) or the impacts/consequences of circular practices on the sustainability performance ?	<b>Intrinsic (Recirculation of Resources)</b>
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Circularity Loop*</b> Are you considering a particular loop/class of the circular economy (i.e. Class A = Maintain & Prolong ; Class B = Reman. & Reuse ; Class C = Recycle) ?	
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Dimensionality*</b> Are you looking for more particularly for a tool with a single and unique indicator or for a framework including a set of multiple indicators ?	
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Usages &amp; Purposes*</b> (Filter Not Available - Under Construction)	
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Transversality*</b> Are you looking for generic tool(s)/indicator(s) that could be applied for a wide variety of products/organizations or for more specific ones designed for a particular industrial field ?	
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓	
<b>*Type &amp; Format*</b> What kind of tool(s)/indicator(s) would you prefer to use ?	<div style="border: 1px solid black; padding: 2px;">           Formulas to compute            Computational tool            Dynamic Excel Spreadsheet  <b>Web-based Tool</b>            Assessment framework         </div>