

Circularity Indicators: the Advisor

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CIRCULARITY INDICATORS: THE ADVISOR

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Key words:

Circular economy, circularity indicators, taxonomy, selection tool.

<u>Context:</u> 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.

<u>Description of the tool</u>: 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.

<u>Audience:</u> 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.

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

<u>Internet connection</u>: 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.

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

References:

[1] Geissdoerfer, M., Savaget, P., Bocken, N.M. 2017. The Circular Economy–A new sustainability paradigm? Journal of Cleaner Production, 143, 757-768.

[2] Saidani, M., Yannou, B., Leroy, Y., Cluzel, F. How to assess product performance in the circular economy? Proposed requirements for the design of a circularity measurement framework. Recycling 2017, 2, 6.

[3] Earley, R. 2017. Circular Design Futures. The Design Journal, 20:4, 421-434, doi: 10.1080/14606925.2017.1328164

[4] Saidani, M., Yannou, B., Leroy, Y., Cluzel, F. Hybrid top-down and bottom-up framework to measure products' circularity performance. International Conference on Engineering Design, ICED 17, Aug 2017, Vancouver, Canada.

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		rcularity Indicators The Search Engine The Query Tool
<u>↑↑↑↑↑↑↑↑↑</u>			Material Circularity Indicator
This tool seeker aims to guide designers, engineers, researchers, managers, administrators, decisic makers, etc., in identifying and selecting the most suitable(s) tool(s)/indicator(s) to assess, improv their circular practices according to their specific needs and requirements.	MICIE 0,46	Constraints and a second	
According to a common agreement - shared by academics, industrialists and politics - on the circular economy (CE) related indicators, many tools, index, metrics, indicators have been design standardized definition of what circular economy is, it is of the utmost importance to know w measure in order to use them properly, within the both fuzzy and complex concept of CE. As such	Computing of the MCS	GRANTA	
which the tool seeker will help out identifying most suitable tool(s)/indicator(s) - aims at clarifying at caracterizing each indicator according to relevant criteria in line with circular economy para	the purpose of and adigm and features.	CircularEconomy Coolicit Nearent for an Earling Work!	Assessment from Workshops About
In inputs, several questions to oriente you towards the most suitable tool(s)/indicator(s), will l i) scale of measurement; ii) circularity perspective; iii) circularity performance; iv) circularity loop, vi) usages and purposes; vii) transversality; viii) type and format.	be asked about: ; vi) dimensionality;		All solars and another descent or any solars and another descent or any solars and any solar any sol
In outputs, one or several tool(s)/indicator(s) will be identified and following information wil i) tool/indicator name; ii) working principle; iii) details about systemic level (scale); iv) details a circularity; v) details about the dimensionality and unit; vi) data required to compute the tool/ind usages; viii) type of tool; ix) authors and references; x) internet access ink.	l be displayed: bout the kinds of licator; vii) possible		
ightarrow ightarrow ightarrow Click on the logo above or go directly to the Inputs tab below, to start your rese	arch $\leftarrow \leftarrow \leftarrow$	En	
The present taxonomy of circularity indicators and the seeker tool have been developed by Michael Saidani du the Industrial Engineering Department of CentraleSupelec, Paris-Saclay University, under the supervision of Prol Assistant Prof. Yann Leroy and Assistant Prof. François Cluzel, funded by The French Ministry of Higher Educatio Innovation (Ministère de l'Enseignement Supérieur, de la Recherche, et de l'Innovation), and in collaboration wi Ecology Program at UC Davis, under the supervision of Prof. Alissa Kendall, thanks to the support of the Fulbri	ring his PhD thesis at f. Bernard Yannov, m, Research and th the Industrial ght Commission.	CIRCULARITY TEST - CEIP SC I DENS AND ADDRESS I DENS AND ADDRESS	

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)

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[Indicators, Metrics, Indexes, Framework]	Working Principles (Inputs/Dutputs)	Micro	Neso	Macro	Actual (Effective)	Potential	(Elfects, 35 value)	Intrinsic (Recirculation , Resources)	(Quantitative us Qualitative)	y (SingleiLov or Multiple)	(Systemic & Life Cycle Thinking)	Assessmen	Improvement I Guidance	Managerial or Policy (Choice)	Benchmark (KPI) Communication (Product Labels)	Learning Education	Academics	Organization (Gvm, Env)	Companies (Industrial)	Consulting Agency	Industry. Sector, or Region	Web-based, Formula, etc.)	AccessLink
Recycling Rates (RRs)	Indicators for the circul	a Materials	-	-	N .	-	*	ж	Quantitative [2]	Multiple Indica	Collected mat	Plouantkat	Plimprovem	-	-		(Houpt et al.	-	-	*	Generic (bu	Formulas to r	https://online
End-of-Life Recycling Rates (EoL-FRs)	Various recycling metri	c Materials		-	н			8	Quantitative van	Multiple Indica	Production 8	P (quantitati	Pitobeuse	-	*	S [to provide	Graedel et a	-		*	Generic	Formulas to n	https://digita
Circular Economy Performance Indicator (CEPI)	Formula: the ratio of the	e Materials	÷		н	4	s lberiefits on		Quantitative ICE	Single Indicat	Life Dycle Inw	Plquaritan	in -	P [the indicato	+	*) . ()	Phayeman et	e	*.)	+	Generic Ibu	Formulas to r	https://www.
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Recycling Indices (RIs) for the CE	The Material-Fil espres	s Materials, Pre	-		ж	-	-	×	Quantitative (%)	Single Indican	Bill of Material	-	P (essential	-	P (in order to infor	Pitvilhelp	Van Schaik	-	-	-	Generic	Computation	https://www.r
Cionular Economy Indicator Prototype (CEIP)	The CEIP, using a poirv	a Product-Car	-	-	н	641	-	H.	Quarkitative [so	Single Indicat	Bill of Material	P (quantikati	Sincremen	-	S (products come	Steaminge	Carizor et al	-	-	-	Generic Ibu	Dynamic Exc	https://www.r
Cacular Economy Tookk (CET)	The CET is a 'live-minu	Product-Cer	-	-		H	-	8	Semi-quantkatik	Multiple Indica	Extensive qua	-	P louiok imp	-	S [products come	StoheoMist	Evens and B	-	-	-	Generic	Web-based	https://circul
Circularity Potential Indicator (CPI)	Through a quided que:	Product-Cer	-	-	úd	н	Ed Bok with er	×	Quantitative 0%	Single Indicate	Data required	Playantkat	P Iduring de	Simanagerial	Sinternallestern	Sicheokist	(Saldani et a	-	-	-	Generic	Dynamic Exc.	https://www.
Product-Level Circularity Metric (PCM)	Formula: C = economic	Product-Cer		-	н	[64]	» [economic]	*	Quantitative D/	Single Indicate	Bil of Material	Plauentket	iv -	P la criterion h	P(akeu performa	-	fLinder et al.		-	*	Generic	Formulat to (https://online
Circular Economy Index (CEI)	Formula: Ratio between	ProductsLes			н		x Imaterial val	-	Quantitative D/L	SingleIndex	To compute ti	Plauentket	in	P Ithis indexis	-	*	(C) Maio and	*		+	Specific Ion	Formulas to r	https://dx.do
Circularity Index (CI)	Formula: a - recovered	Products	-	-	8	-	fallenergy rec	*	Quantitative [2]	Multiple Indica	Production 8	Pitheresult		-	Sibenchmarking	-	(Cullen 201)	-		-	Gerreic	Formulas to (https://online
Closed Loop Calculator (CLC)	Kinglisher Cacularity C.	a Products	-	-	н	fal	-	8	Quartitative Leo	Single indicate	Firstly, you ide	Pito help Ki	r -	*	Plenables Kingli	-	-	-	(Kinglisher,	-	Generic	Computation	https://www.l
Material Circularity Indicator (MCI)	The MCI developed by	Material-Cer	Circulativo of	-	н	-	-	×	Quantitative 0%	Single Indican	Detailed Bill of	Plauantkari	-	-	Stmaneriablorod	Sito know w	-	-	-	(EMF. 2015)	Generic find	Dynamic Exc.	https://www.
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Material Reutilization Part (C2C)	The C2C framework pe	Products	Companies	8-	н	N	-	1	Qualitative ("Cra	Single Indicate	Bill of Material	Plassessme	e P Ito determ		P(product label.	d-	÷	*		IC2C.2014)	Generio ICa	Assessment	Happ: Ilway.
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Resource Duration Indicator (FDI)	A new performance me	e Componente	Managerial			8	-	×	Quantitative Itim	Single Indicate	Initial lifetime.	Pliomean	n -	Slatamatas	Pimanagement		Franklin-Jo	-			Generic	Formular to r	https://www.
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Circular Economic Value (CEV)	The Circular Economic	1-	Construction	n -	-	н	-		Quantitative [%]	Single Indican	Material Flow	-	Pithe Caoul	-	Siat a baceline f	d -	Fogaraczy	-	-		Generic Ibu	Formulat to r	http://heal.m
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Circulativ Indicator Project (ICT)	It considers three aspe	d -	Value-chair	-	-	н	alcost saving	-	Quantitative (up)	Multiple Indica	Life Ducle Inst	Sitvilako	NP Ito help or	Pitcouldbe	Slatuelattobe	-	200000000	-	-	Witteria Sier	Generic	Accessment	https://www.
Circular Economy Company Assessment Criteria (CECAC)	The assessment aims a		Organization	n -		a	-	ĸ	Qualitative (vario	Multiple Indica	Buriness Moo		-	P Ito make de	Site communica	-		*	-	WEDD 2019	Generic	Computation	htp://www.
Circularity Assessment Tool(CAT)	The goal of CAT is to en		Organization	n -		н	x lvalue creat	-	Quartitative (va	Multiple Indica	Business Moo	Plohelpin	P linsights to	*	*		-	*	-	IPGGM 201	Generic	Computation	https://www.
Circle Assessment (CA)	A circularity assessment	-	Organization	-	-	8	s lasses the	-	Quantitative fea	Multiple Indica	Buriness Moo	P (data colle	Plorevides	P Ito accelera	-	-	-	-	-	(Circle Econ	Generic	Online Surve	https://www.
Cerular Benefits Tool(CBT)	The model amedito ca	k -	Organization			u .	v faunided v a	-	Outprotative fea	id Multiple Indica	Life Coole Inst	Pimeanain		Plenategione	-	-	-	-	-	(Advancing)	Generic	Accessment	Perce Iborry
Framework for implementing CE in organizations (BS 8001)	The BS 8001 quide is in	y -	FrameworkF	4-	-	H	x (direct and is	-	Qualitative fuark	Multiple Indica	Business Mod	-	P Ito contina	P (aimed at et	-	-	-	-	-	IBSI Group.	Generic	Assessment	https://www.l
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Evaluation Indicator System of Circular Economy (EISCE)	Evaluation index system		Enterprises		н	×	*	8	Quantitative fua	Multiple Indica	Resources in	P(suitable f	Simprovem	-	-	*	(Zhou et al.				Specific Bo	Formulas to r	https://ckese
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Evaluation of CE Development in Cities (ECEDC)	An indicator framework	-	+	Citylevel	н	-	×	-	Quantitative fea	a 20 individual in	Life Cycle Inv	Plouantkati	-	-	-	-	IListal, 201	-	-	-	Generic (Ch	Assessment'	https://www.s
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EU Resource Efficiency Scoreboard (RES)	The EU Resource Effici	-	-	EU and nati	0 X	-	8	8	Quantitative fea	Mutiple Indica	Life Ducle Invi	Plassessing		-	-	-	-	European C	-	-	Generic IEU	Assessment'	https://ec.ec
Economy-Wide Material Flow Analysis (EW-MFA)	Proposed a quantitativ	a -		EUlevel	н	-		8	Quantitative fea	standardized	Materials/Sub	Plassess th	Plindeated	-		-	Haar et al.	-	-		Generic (EU	Assessmert'	Fimps: Ilonâne
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Indicators for Eco-design for CE in Europe (IECEE)	Indicators for eco-desi	d -	-	EUlevel	H.	-	-	H.	Quantitative fea	Multiple Indica	Materials/Sub	Playanikati		P (policy gues	-	-	-	(EEA, 2016) E	-	-	Generic (EU	Assessment	https://www.
Indicators for Production for CE in Europe (IPCEE)	Indicators for production	d-		EUlevel	н	-	*	×	Quantitative fea	Multiple Indica	Materiale/Sub	Plauacitati		P Incline ques	-	40	4	IEEA 20161E	-		Generic (EU	Assessment	https://www.
Indicators for Consumption for CE in Europe (ICCEE)	Indicators for consump	a -		EUlevel	н	*		N.	Quartitative fea	Multiple Indica	Materiala/Sub	Plaumikat	in -	P Ipolicy gues		*	+	IEEA , 201618		*	Generic IEU	Assessmert	https://www.
Care day Instructs President F110" (PF10)	Maasuting the impacts		*	Filandnati	0.×	-	vieconomic		Charge tation from	Multiple Indica	I de Corte Inc	Planettin	d.	D farriet the F		10	-	(EC. 2016).be			Generic (EL)	Arrentert	A https://cicad

Figure 3: Input data

Circularity Indicators _ The Advisor Target the Right Indicators for Your Organization	Inputs - Filtering Selection Criteria
<u> </u>	
 Instruction - 1/ Fill in the yellow cells that can be scrolled, as a filter to identify the most suitable circulaity tool(2/ Click on the logo above to launch the search and have access to your personalised inventory o N.B. You can leave one or several criteria blank to have access to a wider variety of For instance, if all criteria fields are left emply, every tool available among the inventor 	s)/indicator(s) to your needs ↓↓↓ f circularity tools/indicators. ↑↑↑ proposed solutions. ory will be displayed.
	+++++++++++++++++++++++++++++++++++++++
Scale of Measurement 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) ?	Micro
	+++++++++++++++++++++++++++++++++++++++
Circularity Perspective (Retro- or Pro-) Are you interested in knowing actual and effective circularity perfomances (retrospective) or potential performances of circular practices e.g. during product development (prospective) ?	Potential
	+++++++++++++++++++++++++++++++++++++++
Circularity Performance 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 ?	Intrinsic (Recirculation of Resources)
	+++++++++++++++++++++++++++++++++++++++
Circularity Loop Are you considering a particular loop/class of the circular economy (i.e. Class A = Maintain & Prolong ; Class B = Reman. & Reuse ; Class C = Recycle) ?	
	+++++++++++++++++++++++++++++++++++++++
Dimensionality 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 ?	
Usages & Purposes (Filter Not Available - Under Construction)	
Transversality 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 ?	
Type & Format What kind of tool(s)/indicator(s) would you prefer to use ?	Formulas to compute Computational tool Dynamic Excel Spreadsheet Web-based Tool Assessment framework

4