Supplementary Materials

Associated article:

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1) Summary

This document is a supplement to the article cited on the cover page. This document contains the details on the circular economy (CE) indicator classification, CE indicator list, as well as flywheel design study calculations, assumptions, and references.

2) CE indicators: Exclusion Criteria

The primary goal of our work was to analyze, and classify input terms for computing micro-level, resource-based CE indicators, applicable to circular product design. For this, a list of resource-based CE indicators were compiled from Jerome et al. (2022). Additionally, micro-level indicators were compiled from De Pascale et al. (2021). Our exclusion criteria for identifying relevant micro-level, resource-based CE indicators CE indicators are presented below.

Exclusion criteria for screening micro-level resource-based CE indicators:

EC 1. CE indicators that need to be derived from specific software/toolkits were excluded.
EC 2. CE indicators that include cost/revenue as an evaluation criterion were excluded.
EC 3. Domain- and product-specific CE indicators (e.g., CE indicators specific to electrical applications) were excluded.
EC 4. CE indicators requiring qualitative inputs were excluded.
EC 5. CE indicators applicable to product families were excluded.
EC 6. CE indicators focusing on social and economic dimensions were excluded.
EC 7. CE indicators that include life cycle assessment (LCA) as evaluation criterion were excluded.

3) CE Indicators Classification

The table below lists the screened CE indicators, corresponding classification of inputs into E-, M-, T-, and other-terms, and relevant formulae, wherever applicable.

Please note that CE indicators marked with an asterisk (*) are excluded from our analysis.

CE Indicator	Energy (E) Terms	Mass (M) Terms	Time (T) Terms	Other Terms	Formulae	Source
Energy Intensity	Energy demand in extraction and production (E_{demand}) Internally derived energy (E_{int})	Total mass of the product (M_{prod}) Mass of useful co-products ($M_{co.prod}$)			$E = \frac{E_{demand} - E_{int}}{M_{prod} + M_{co.prod}}$	Jerome et al. (2022)
Waste Factor		Mass of waste in extraction, material production and product manufacturing (M_{waste}) Total mass of the products (M_{prod}) Mass of useful co-products ($M_{co.prod}$)			$WF = \frac{M_{waste}}{M_{prod} + M_{co.prod}}$	Jerome et al. (2022)
Feedstock Intensity		Mass of primary feedstock needed in production ($M_{primary.mat}$) Total mass of the products (M_{prod}) Mass of useful co-products ($M_{co.prod}$)			$FI = \frac{M_{primary.mat}}{M_{prod} + M_{co.prod}}$	Jerome et al. (2022)
Process Material Circularity		Mass of process auxiliary in production that have been recovered and reused ($M_{rec.prod.aux,i}$) Total mass of production auxiliary ($M_{prod.aux,i}$)			$PMC = \sum_{i=1}^{n} \left(\frac{M_{rec.prod.aux,i}}{M_{prod.aux,i}} \right) \times \frac{100}{n}$	Jerome et al. (2022)
Recycled Content Rate		Mass of recycled material in the product (M_{rec}) Total mass of the product (M_{tot})			$RCR = \frac{M_{rec}}{M_{tot}} \times 100$	Jerome et al. (2022)

Recycled Content		Recycled feedstock ($M_{rec.feed}$) Total feedstock in production ($M_{tot.feed}$)			$RC = \frac{M_{rec.feed}}{M_{tot.feed}}$	Jerome et al. (2022)
Product Renewability		Percentage of renewable resources incorporated in the product ($M_{bio.feed}$) Net mass of the resources ($M_{tot.feed}$)			$PR = \frac{M_{bio.feed}}{M_{tot.feed}} \times 100$	Jerome et al. (2022)
Recyclability Rate		Total mass of the product (M_{tot}) Mass of the product component. (M_i) Rate of material mass potentially reusable at end-of-life. ($X_{reuse,i}$)			$Rreuse = \frac{\sum_{i=1}^{n} M_i X_{reuse,i}}{M_{tot}} \times 100$	Jerome et al. (2022)
Old Scrap Collection Rate		Mass entering recycling ($M_{entering.rec}$) Mass collected for recycling ($M_{collected.rec}$)			$OSCR = \frac{M_{entering.rec}}{M_{collected.rec}}$	Jerome et al. (2022)
Recycling Process Efficiency Rate		Material entering recycling ($M_{rec.eol}$) Material leaving recycling process and entering the old scrap market ($M_{entering.rec}$)			$RPER = \frac{M_{rec.eol}}{M_{entering.rec}}$	Jerome et al. (2022)

End-of-life Recycling Rate		Material entering the old scrap market ($M_{rec.eol}$) Material collected for recycling ($M_{collected.rec}$)			$EOL-RR=\frac{M_{rec.eol}}{M_{collected.rec}}$	Jerome et al. (2022)
Old Scrap Ratio		Recycled material at the end-of-life ($M_{rec.eol}$) Total mass of the material entering the recycling flow ($M_{rec.eol}+M_{rec.scrap}$)			$SR=\frac{M_{rec.eol}}{M_{rec.eol}+M_{rec.scrap}}$	Jerome et al. (2022)
Recyclability Rate		Total mass of the product (M_{tot}) Mass of the component (M_i) Mass fraction of the component which is potentially recyclable at End-of-Life ($X_{rec,i}$)			$Rrec=\frac{\sum_{i=1}^{n}M_iX_{rec,i}}{M_{tot}}\times 100$	Jerome et al. (2022)
Collection Rate		Material collected for recycling ($M_{collected.rec}$) Mass that enters the end-of-life phase (M_{eol})			$CR=\frac{M_{collected.rec}}{M_{eol}}$	Jerome et al. (2022)
Recycling Rate		Material that is recycled (M_{rec}) Material that enters the end-of-life phase ($M_{collected.rec}$)			$RR=\frac{M_{rec}}{M_{collected.rec}}$	Jerome et al. (2022)
Recycle Benefit Ratio	Emergy required to extract primary resources ($Em_{extract}$) Emergy needed to recycle the same material (Em_{rec})				$RBR=\frac{Em_{extract}}{Em_{rec}}$	Jerome et al. (2022)

Recycle Yield Ratio	Energy in a recycled material (Em_{inRec}) Energy required to recycle the material (Em_{Rec})				$RYR = \frac{Em_{inRec}}{Em_{Rec}}$	Jerome et al. (2022)
Landfill to Recycle Ratio	Energy needed to landfill a material ($Em_{landfill}$) Energy required to recycle the same material (Em_{rec})				$LRR = \frac{Em_{landfill}}{Em_{rec}}$	Jerome et al. (2022)
Recoverability Rate		Total mass of the product (M_{tot}) Mass of the component (M_i)		Fraction of component that is potentially energy recoverable ($X_{recov,i}$)	$Rrecov = \frac{\sum_{i=1}^{n} M_i X_{recov,i}}{M_{tot}} \times 100$	Jerome et al. (2022)
Circular Economic Value	Non-renewable energy used (E_f) Renewable energy used in production (E_s) Energy recovered at the EOL (E_l) Energy required in recycling (E_c)	Primary material used in production (M_P) Secondary material used in production (M_s) Non-recyclable material at end-of-life (M_d) Recyclable material at end-of-life (M_r)			$CEV = (\frac{M_P}{M_p + M_s} + \frac{M_d}{M_r + M_d} + \frac{E_f}{E_s + E_f} + \frac{E_l}{E_c + E_l})/4 \times 100$	Jerome et al. (2022)
Circularity Index	Energy required to produce recycled material (E_{rec}) Energy required to produce primary material ($E_{primary}$)	Mass of material recovered through recycling (M_{rec}) Total demand of a material (M_{tot})			$CI = \frac{M_{rec}}{M_{tot}}(1 - \frac{E_{rec}}{E_{primary}})$	Jerome et al. (2022)

Material Reutilization Score		Mass fraction of recycled material ($Fr_{recycled}$) Mass fraction of renewable content in the product (Fr_{ren}) Mass fraction that is potentially recyclable ($Fr_{recyclable}$) Mass fraction that is biodegradable (Fr_{bio}) Mass fraction that is compostable at end-of-life (Fr_{comp})			$C2C = (Fr_{recycled} + Fr_{ren}) + 2(Fr_{recyclable} + Fr_{bio} + Fr_{comp})/3 \times 100$	Jerome et al. (2022)
Linear Flow Index applied to Single Products		Primary materials in the product (V) Total mass of unrecoverable waste as the EOL (W) Total mass of the product (M_t) Mass of waste generated when producing the recycled material used in the product (W_f) Waste from recycling at the end-of-life (W_c)			$LFI2 = \frac{V + W}{2M_t + \frac{W_f - W_c}{2}}$	Jerome et al. (2022)
Circular Process Energy Intensity	Energy demand in extraction and production (E_{demand}) Internally derived energy (E_{int})	Total mass of end-product (M_{prod}) Mass of useful co-products ($M_{co.prod}$) Mass of recycled material at the end-of-life ($M_{re.prod}$)			$CPEI = \frac{E_{demand} - E_{int}}{M_{prod} + M_{co.prod} + M_{re.prod}}$	Jerome et al. (2022)

Circular Process Waste Factor		Mass of waste in extraction, material production and product manufacturing (M_{waste}) Total mass of the product (M_{prod}) Mass of useful co-products, ($M_{co.prod}$) Mass of recycled material at the EoL ($M_{re.prod}$)			$CPWF = \frac{M_{waste}}{M_{prod} + M_{co.prod} + M_{re.prod}}$	Jerome et al. (2022)
Circular Process Feedstock Intensity		Mass of primary feedstock needed in production ($M_{primary.mat}$) Total mass of the products. Mass of useful co-products Mass of recycled material at the EoL ($M_{re.prod}$)			$CPFI = \frac{M_{primary.mat}}{M_{prod} + M_{co.prod} + M_{re.prod}}$	Jerome et al. (2022)
Longevity			Initial lifetime (L^A) Remanufacturing Lifetime (L^B) Recycling Lifetime (L^C)		$Longevity = L^A + L^B + L^C$	Jerome et al. (2022)
Circularity			Number of Initial uses (N^A) Contribution from Recycling (N^B) Contribution from Remanufacturing (N^C)		$Circularity = N^A + N^B + N^C$	Jerome et al. (2022)
Material Circularity Indicator		Mass of primary materials in the product (V) Total mass of unrecoverable waste as the EoL (W) Total mass of the product (M_t)	Product design life based on market average (L_{av}) Use intensity of the product designed for (U_{av}) Actual realised lifetime (L)		$LFI = \frac{V + W}{2M + \frac{W_F - W_c}{2}}$ $X = (\frac{L}{L_{av}})(\frac{U}{U_{av}})$	Jerome et al. (2022)

		Mass of unrecoverable waste associated with producing the recycled material contained in the product (W_f) Mass of unrecoverable waste when recycling parts of a product (W_c)	Actual use intensity of the product (U)		$MCI = 1 - \frac{LFI}{X}$	
Product Circularity Indicator		Total primary material needed to produce the product (V) Total unrecoverable waste from production and end-of-life (W) Recycled material exchanged with other product systems (R) Mass of components that are exchanged with other product systems (C) Total primary material needed in a theoretical fully linear system (V_{linear}) Unrecoverable waste generated in a theoretical fully linear system (W_{linear})	Product design life based on market average (L_{av}) Use intensity of the product designed for (U_{av}) Actual realised lifetime (L) Actual use intensity of the product (U)		$LFI = \frac{V + W + 0.5\lvert R\rvert + 0.5\lvert C\rvert}{V_{linear} + W_{linear}}$ $X = (\frac{L}{L_{av}})(\frac{U}{U_{av}})$ $MCI = 1 - \frac{LFI}{X}$	Jerome et al. (2022)
* Relative Net Loss (EC 4)		Content System loss rate	Service lifetime	Function	$RNL = \frac{content_{i,j,k}}{content_{i,j,BAU}} * \frac{function_{j,BAU} * service\ lifetime_{j,BAU}}{function_{j,k} * service\ lifetime_{j,k}} * system\ loss\ rate_{i,j,k}$	Jerome et al. (2022)
* Disassembly Effort Index (EC 2)				Table based data required to calculate the score Cost terms		De Pascale et al. (2021)

* CE Toolkit (EC 1)				Software application based Questionnaire-based		De Pascale et al. (2021)
* End-of-life Index (EC 2)				Product Index Module Index Total Cost of Disposal Total cost of disassembly Total cost of Recycling Total cost of Remanufacturing Disassembly- Bill of Material		De Pascale et al. (2021)
* Recycling Indicator Set: - Weight recovery of target material - Recovery of scarce materials - Closure of material cycles - Avoided environmental burdens (EC 3)		Total weight of recycled target materials Total weight of the input of the recycling process		Economic importance of the material Supply risk of the material Current market price of output fraction Current market price of the material present in the EEE Environmental burden associated with the production of the material that is avoided by the recycled output fraction Environmental burden associated with the production of the material present in the EEE		De Pascale et al. (2021)

				Number of materials/output fractions		
* Reuse Potential Indicator (EC 4)				Material characteristics as a function of technology development		De Pascale et al. (2021)
* CE Index (EC 2)				Material Value recycled from EOL product (Mv) Material value needed for (re-)producing EOL product ($Mvre$) Economic value	$CEI = \frac{Mv}{Mvre}$	De Pascale et al. (2021)
* Recyclability Benefit Rate (EC 7)	All impacts can be measured in Emergy terms (MJ_{ex}):- The impact of disposing of 1 kg of the *i*th material of the *j*th part ($D_{n,i,j}$) The impact of producing 1 kg of the *i*th virgin material of the *j*th part ($V_{n,i,j}$) The impact of producing 1 kg of the *i*th recycled material of the *j*th part ($R_{n,i,j}$) The impact of manufacturing the product (M_n) The impact of the use phase of the product (U_n)	Mass of the *i*th material ($D_{n,i,j}$)			$RBR_n = \frac{\sum_{j=1}^{P}\sum_{i=1}^{N} m_{recyc,i,j}\, RCR_{i,j}\left(V_{n,i,j} + D_{n,i,j} - R_{n,i,j}\right)}{\sum_{j=1}^{P}\sum_{i=1}^{N} c\, V_{n,i,j} + M_n + U_n + \sum_{j=1}^{P}\sum_{i=1}^{N} m_{i,j}\, D_{n,i,j}}$	De Pascale et al. (2021)

* Eco-cost Value Ratio (EC 2, EC 7)						De Pascale et al. (2021)
* CE Indicator Prototype (EC 1)						De Pascale et al. (2021)
* Synthetic Economic Environmental Indicator (EC 2, EC 3)						De Pascale et al. (2021)
* Recycling Indices (EC 1)						De Pascale et al. (2021)
* CE Performance Indicator (EC 7)	Actual benefit (Ab) Ideal benefit according to quality (Ib) (Benefits expressed in natural resource consumption (MJex))				$CPI = \frac{Ab}{Ib}$	De Pascale et al. (2021)

* Product-level Circularity Metric (EC 2)				Economic value of recirculated parts (Er) Economic value of all parts (Ep)	$PLCI = \frac{Er}{Ep}$	De Pascale et al. (2021)
* Value-based Resource Efficiency Indicator (EC 2)				Weights (measure in prices) (W_i) Output Value (measure in prices) (Y) Resources (in volumes) (X_i)	$VRE = \frac{Y}{\sum_i W_i X_i}$	De Pascale et al. (2021)
* End-of-Life Indices: - Reuse index (I_{EoL-Ru}) - Remanufacture Index (I_{EOL-Rm}) - Recycling Index (I_{EoL-Rc}) - Incineration Index ($I_{EOL-Inc}$) (EC 2)				All terms are either made of cost factors or include cost factors/ value terms	$I_{EoL-Ru} = \frac{V_{Re} + V_{Mat} + V_{Man} - C_{RL} - C_{Sd} - C_C}{V_{Re} + V_{Mat} + V_{Man}}$ $I_{EOL-Rm} = \frac{V_{Rem} + V_{Mat} + V_{Man\_s} - C_{RL} - C_{Sd} - C_C - C_{Rem}}{V_{Rem} + V_{Mat} + V_{Man\_s}}$ $I_{EoL-Rc} = \frac{V_{Rc} + V_{En} + C_{RL} - C_{dd} - C_C}{V_{Rc} + V_{En}}$ $I_{EOL-Inc} = \frac{V_{EInc} + C_{RL} - C_{dd}}{V_{EInc}}$	De Pascale et al. (2021)
* Recycling Desirability Index (EC 4)		Mass of Discrete Material in the product (M_i) Total product mass (M_T)		Material Security Index of recycling a particular material (S_i) Top scale of material security index (Constant) (S_{top})	$D_{MSI} = \sum_{i=1}^{n} \left(\frac{M_i S_i}{M_T S_{top}} \right)$ $D_{TRL} = \sum_{i=1}^{n} \left(\frac{M_i R_i}{M_T R_{top}} \right)$	De Pascale et al. (2021)

		Complexity Index (obtained from mass fraction) (H)		Technology readiness level assessment of recycling technology for a particular material (R_i) Top scale of technology readiness level (Constant) (R_{top}) Top scale of material complexity index (Constant) (H_{top})	$D_{Simplicity} = 1 - \left(\frac{H}{H_{top}}\right)$ $D_{Desirability} = \left(D_{Simplicity} + D_{MSI} + D_{TRL}\right)$	
* Sustainable Circular Index (EC 6)				Consists of different dimensions: Social sustainability Economic sustainability Environmental sustainability Circularity		De Pascale et al. (2021)
* Global Resource Indicator (EC 6)		Y: Recycling rate and dispersion rate (Dimensionless)		X: CML (LCIA method) Characterisation factors Z: Geopolitical stability	$GRI = \frac{X}{Y * Z}$	De Pascale et al. (2021)
* Linear Flow Index for – Product Families (EC 5)						De Pascale et al. (2021)

* Circularity Design Guidelines (EC 4)						De Pascale et al. (2021)
Effective Disassembly Time			Standard disassembly time (T_s)	Corrective Factor (CF_k)	$T_e = T_s \prod_k CF_k$	De Pascale et al. (2021)
Ease of Disassembly Metric			Time: Tool change (TC_i) Identifying (I_i) Manipulation (M_i) Positioning (P_i) Disconnection (D_i) Removing (R_i)		$eDiM= \sum_{i=1}^{i=n} TC_i + I_i + M_i + P_i + D_i + R_i$	De Pascale et al. (2021)
* End-of-Use Product Value Recovery (EC 2)						De Pascale et al. (2021)
* Remanufacturing with the aid of the Product Profile tools (EC 1)						De Pascale et al. (2021)
* Circularity Calculator (EC 1)						De Pascale et al. (2021)

4) Results: Flywheel Design Study

The following section contains detailed values and references used for developing the three case studies. Figure 4-1 presents the developed framework applied to the flywheel case study. Figure 4-1 shows flywheel design information fed to each lifecycle phase simulation model. Configuration parameters are used in Case study 3 for performing the manufacturing simulation. Appropriate references are used as a black box simulation model for extraction, manufacturing, and end-of-life phases. The use phase incorporates a fatigue life simulation model of a flywheel instead. The E-, M- and T-outputs from CE computation stages are given as inputs to the computed CE indicators: EI, WF and MCI. Model interactions across lifecycle phases are out of the scope of this paper and thus ignored in this study description.

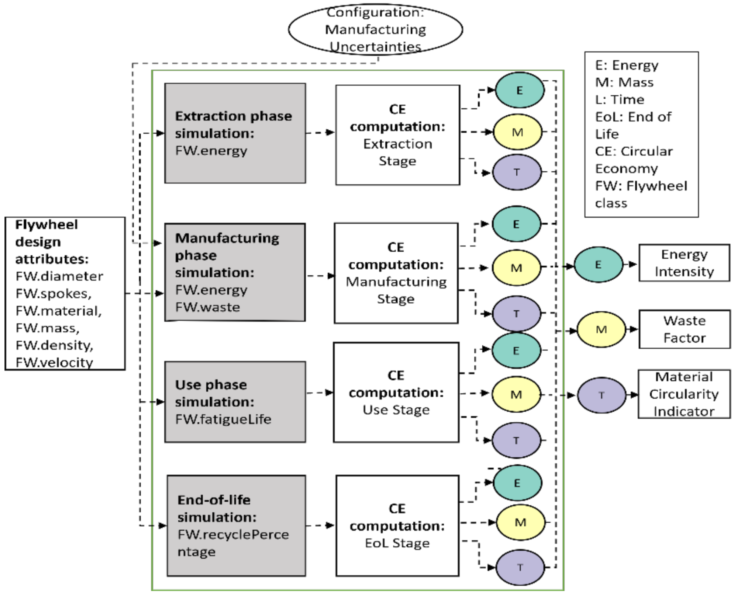

Figure 4-1: Framework applied to the flywheel design study.

a) Case study 1 - Flywheels with identical mass

Table 1 contains the necessary data used for conducting this study.

Table 1: Case study 1 - References, assumptions and obtained simulation values used for the calculation of CE indicators.

Flywheel Attributes	**Case study 1**	
	Design A	*Design B*
Diameter (m)	0.6344	0.5450
Number of spokes	3	6
Density (kg/m^3)	7200	7200
Mass (kg)	7.2909	7.2909
Volume (m^3)	0.0010	0.0010
Extraction:		
Extraction (MJ/kg)	32.35	32.35
Extraction Energy (MJ)	235.8606	235.8606
Extraction Energy (J)	235860615	235860615
Manufacturing:		
Casting (MJ/kg)	10.55	10.55
Casting Energy (MJ)	76.9189	76.9189
Casting (J)	76918995	76918995
Waste	0.3645	0.3645
Milling (MJ/kg)	9.108	9.108
Milling Energy (J)	182160	182160
Use:		

Lifetime (Rotational velocity: 400 rad/s, rotational acceleration: 60 rad/s^2, zero based, only one direction)	3.80 E+04	8.70 E+04
Stress (Von-Misses) (N/m^2)	6.73 E+05	1.66 E+06
End-of-Life:		
Recycling Percentage (%)	80	80
CE Indicators:		
Energy Intensity (EI) (J/kg)	42924984.57	42924984.57
Waste Factor (WF)	0.05	0.05
Material Circularity Indicator (MCI)	0.9473	0.9770
LFI for MCI	0.2	0.2
X for MCI	3.80	8.70

b) Case study 2 - Flywheels with same stored energy

Table 2 presents the necessary data and appropriate assumptions for conducting this study. Design A and Design B need different inertia and rotational velocities to have the same stored energy. I_A and I_B represent inertia values for Design A and B respectively. Similarly, ω_A and ω_B represent rotational velocities for Design A and B.

$$\mathrm{I}_{\mathrm{A}} = \begin{bmatrix} 0.0825 & 0.0000 & 0.0000 \\ 0.0000 & 0.0825 & 0.0000 \\ 0.0000 & 0.0000 & 0.1646 \end{bmatrix} \quad , \quad \omega_A = [0 \quad 0 \quad 733.48]$$

$$I_B = \begin{bmatrix} 0.2192 & 0.0000 & 0.0000 \\ 0.0000 & 0.2192 & 0.0000 \\ 0.0000 & 0.0000 & 0.4373 \end{bmatrix} , \quad \omega_B = [0 \quad 0 \quad 450]$$

Table 2: Case study 2 - References, assumptions and obtained simulation values used for the calculation of CE indicators.

Flywheel Attributes	**Case study 2** *Design A*	 *Design B*
Material	Aluminium	Cast Iron
Diameter (m)	0.5386	0.5386
Number of spokes	6	6
Density (kg/m^3)	2710	7200
Mass (kg)	2.7134	7.209
Volume (m^3)	0.0010	0.0010
Extraction:		
Extraction Energy (MJ/kg)	194.5	32.35
Extraction Energy (MJ)	527.7624	233.2112
Extraction Energy (J)	527762397.6	233211150
Manufacturing:		
Casting Energy (MJ / kg)	11.25	10.55
Casting Energy (J)	30526102.69	76054950
Waste (Percent of mass)	0.1357	0.3605
Milling (kWh/kg) (ecoinvent)	6.0886	2.539
Milling Energy (MJ/kg)	21.9190	9.1404
	0.0543	0.1442

Milling Energy (J)	1189515.39	1317862.872
Use:		
Lifetime (Design A: Centrifugal force: 733.48, acceleration: 60 rad/s^2; Design B: Centrifugal force: 450, acceleration: 60 rad/s^2)	1.05 E+06	2.37 E+04
Stress (Von-Misses) (N/m^2)	2.71 E06	2.11 E06
End of Life:		
Recycling Percentage	57	80
Indicators:		
EI (J/kg)	206188380.5	43082808
WF	0.05	0.05
MCI	0.996	0.915
LFI for MCI	0.43	0.2
X for MCI	1.05 E+02	2.37 E+00

c) Case study 3 - Sensitivity analysis

Case study 3 analyses the sensitivity of CE indicators to configuration parameters. Appropriate references/assumptions are mentioned in Table 3. We performed a Monte Carlo simulation with 1 E+06 iterations for each design.

Table 3: Case study 3- References, assumptions and obtained simulation values used for calculation of CE indicators.

Flywheel Attributes	Case study 3	
	Design A	*Design B*
	Cast Iron	Aluminium
Diameter (m)	0.5	0.5
Number of spokes	6	6
Density (kg/m^3)	7200	2710
Mass (kg)	6.726	2.5316
Volume (m^3)	0.001	0.001
Extraction:		
Extraction Energy (MJ/kg)	32.35	194.5
Extraction Energy (MJ)	217.5861	492.3962
Extraction Energy (J) **(A)**	217586100	492396200
Manufacturing:		
Casting (MJ / kg)	10.55	11.25
Casting Energy (MJ)	70.9593	28.4805
Casting Energy (J) **(B)**	70959300	28480500

Milling Energy (kWh/kg)	Log Normal distribution: Mean: 2.53916 Standard Deviation: 1.2214	Log Normal distribution: Mean: 6.08861804691664 Standard Deviation: 1.2214
Milling Energy (J/kg)	lognormal (log (2.5392), sqrt (1.2214)) *3.6 *10^6	lognormal (log (6.088), sqrt (1.2214)) *3.6 *10^6
(C)	2/100*7.2909*Milling Energy	2/100*2.5316*Milling Energy
CE Indicator: Energy Intensity (J/kg)	**(A+B+C)**/ Mass	**(A+B+C)**/ Mass
Coefficient of Variance	0.0119	0.0061

References:

De Pascale, A., Arbolino, R., Szopik-Depczyńska, K., Limosani, M., & Ioppolo, G. (2021). A systematic review for measuring circular economy: The 61 indicators. *Journal of Cleaner Production*, *281*, 124942.

Jerome, A., Helander, H., Ljunggren, M., & Janssen, M. (2022). Mapping and testing circular economy product-level indicators: A critical review. *Resources, Conservation and Recycling*, *178*, 106080.