SUPPLEMENTARY MATERIAL FILES

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Article:
Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

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SUMMARY

SUPPLEMENTARY MATERIAL S1 - Literature LCA in LIBs recycling

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Table 1. LCA studies on LIBs recycling.

Reference	Country	LIBs chemical composition *	Product type	Recycling type	Functional Unit	System boundaries
Liu et al. (2023)	China	LFP	LIBs of EV	Mechanochemical oxidation and Hydrometallurgical oxidation	1 kg spent LiFePO4 battery	Gate to Gate
Chen et al. (2023)	China	LFP/NMC	LIBs of EV	Direct recycling and Hydrometallurgical	LIBs with a nominal capacity of 1 kWh	Gate to Cradle
Alipanah et al. (2023)	USA	NMC	Unspecified	Bioleaching	1 kg of cobalt recovered from the black mass as the main product.	Gate to Gate
Wu et al. (2023)	China	LMO	General applications	Pyrometallurgical; Hydrometallurgical and Direct Recycling	1 kg of spent cell	Gate to Gate
Cao et al. (2023)	China	LCO/NMC/ LFP	Unspecified	Hydrometallurgical	Recycling 1 kg of Cobalt	Gate to Gate
Du et al. (2022a)	China	NMC/LFP	LIBs of EV	Hydrometallurgical	One LIB with 1 kWh of capacity for EVs	Cradle to Grave
Blomeke et al. (2022)	Germany	NMC	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Mechanical	1 ton of used lithium-ion traction batteries from electric vehicles to materials recovering	Grave to Gate
Kallitsis et al. (2022)	United Kingdom	NMC	LIBs of EV	Pyrometallurgical; Hydrometallurgical	1 kWh nominal battery capacity	Grave to Gate
Chen et al. (2022)	China	NMC	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Direct Recycling	1 kWh NMC811 Battery for an EV	Cradle to Cradle

Dunn et al. (2022)	USA	NCX(NMC E NCA) / LFP	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Direct Recycling	Recycle 1 kg of LIB materials at pack level	Grave to Cradle
Duarte Castro et al. (2022)	Italy	NMC	LIBs of EV	Hydrometallurgical	1 battery (3.8 kg, 148.5 Wh) and 1 battery cell (569 g, 37.1 Wh)	Gate to Gate
Iturrondobeitia et al. (2022)	Spain	NMC	LIBs of EV	Hydrometallurgical	1 kg of cathode treated	Gate to Gate
Feng et al. (2022)	China	LFP/NMC	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Direct Recycling	Battery of 1kWh	Cradle to Grave
Koroma et al. (2022)	Belgium	NMC	LIBs of EV	Pyrometallurgical	1 kg treated	Cradle to Grave
Wang et al. (2022)	China	LFP	LIBs of EV	Pyrometallurgical; Hydrometallurgical	The mass of the 1 kWh LFP battery: 8.73 kg	Cradle to Grave
Quan et al. (2022)	China	LFP/NMC	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Direct Recycling	The nominal capacity of a battery of 1 kWh	Cradle to Grave
Du et al. (2022b)	China	NMC	LIBs of EV	Hydrometallurgical	Production of 1 kg of NiCoMn ternary cathode materials.	Grave to gate
Wu et al. (2022)	USA	LCO	Unspecified	Pyrometallurgical; Hydrometallurgical and Direct Recycling	1 kg LCO obtained from spent LIBs	Gate to Gate
Jiang et al. (2022)	China	LFP/NMC	LIBs of EV	Hydrometallurgical and Direct recycling	1 kg recycled or manufactured battery cell	Cradle to grave
Chen et al. (2022)	USA	LFP/NMC	Unspecified	Hydrometallurgical	1 kg of graphite recycled	Gate to Gate
Souza et al. (2022)	Brazil	Unspecified	LIBs of mobile phones	Hydrometallurgical	1 kg of recovered cobalt	Gate to Gate
Rey et al. (2021)	Spain	LCO	LIBs general	Pyrometallurgical and Hydrometallurgical	1 kg of regenerated graphite	Gate to Gate
Yu et al. (2021)	China	NMC	LIBs of Electrical Vehicle (EV)	Pyrometallurgical; Hydrometallurgical and Physical Recycling	kg of battery	Cradle to Gate

Zhang et al. (2021)	China	Severals	LIBs of EV	Hydrometallurgical	1000 kg of spent saggars	Cradle to Gate
Sadhukhan & Christensen (2021)	United Kingdom	LMO	Battery energy storage systems (BESS)	Pyrometallurgical and Hydrometallurgical	1 kg of battery	Cradle to grave
Kikuchi et al. (2021)	Japan	NMC	LIBs of EV	Hydrometallurgical	1 kg of the positive electrode in LIB	Cradle to grave
Rinne et al. (2021)	Finland	Li-Ion general	LIBs of EV	Hydrometallurgical	Treatment of 1 kg of crushed battery waste	Gate to Gate
Kurz et al. (2021)	Germany	NMC	LIBs of EV	Functional recycling (Waterjet Based Recycling)	Recycling a kilogram of traction battery	Gate to gate
Lin et al. (2021)	USA	LCO	Laptops	Hydrometallurgical	The extraction of Li and Co from 1 kg of LiCoO 2 powder	Gate to Gate
Liu et al. (2021)	China	NMC / LFP	Electric bicycles	Pyrometallurgical and Hydrometallurgical	Total distance 100 km powered by a battery pack (4 × 12 V, 20 Ah)	Cradle to Grave
Xu et al. (2021)	USA	LCO	No detailed	Direct recycling	Recycle 1kg of spent LIBs	Gate to Gate
Rajaeifar et al. (2021)	United Kingdom	NMC	LIBs of EV	Pyrometallurgical	Treatment of 1 ton of LIB modules	Gate to Gate
Wang & Yu (2021)	Japan	NMC	LIBs of EV	Hydrometallurgical	One LIB of EV with an average weight of 300 kg	Cradle to Grave
Xu et al. (2020)	USA	LFP	LIBs of EV	Direct recycling	Annual plant processing capacity of 10,000 tons of spent batteries	Gate to Gate
Mohr et al. (2020)	Germany	NCA / NMC	LIBs of EV	Pyrometallurgical and Hydrometallurgical	1 kWh of storage capacity provided by the battery cell, calculated based on given energy densities (Wh/kg)	Cradle to Grave
Gao et al. (2020)	USA	LMO	LIBs of EV	Direct recycling	10,000 tons of annual processing capacity from spent LMO batteries	Gate to Gate

Sun et al. (2020)	China	NMC	LIBs of EV	Hydrometallurgical	1 kWh NMC 622 package for a passenger EV	Cradle to Grave
Anwani et al. (2020a)	India	LCO	Mobile phones	Resinterization of the cathode material	10g of spent material entering treatment	Gate to Gate
Anwani et al. (2020b)	India	LCO	Mobile phones	Lixiviação ácida e cozimento	Amount of battery input material has been selected as the functional unit	Gate to Gate
Yang et al. (2020)	China	LFP	LIBs of EV	Hydrometallurgical	One kilowatt hour (1 kW h) of electricity supply	Cradle to Grave
Tao & You (2020)	USA	LMO / NCM / NCA	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Direct Cathode Recycling	Two functional units: 1 kWh of life-cycle electricity delivered and 1 kWh of battery energy storage capacity	Cradle to Cradle
Delgado et al. (2019)	Norway	NMC	Stationary battery	Pyrometallurgical	100 kg entering the process	Cradle to Grave
Yang et al. (2019)	China	NMC / POLYMER	Portable chargers	Hydrometallurgical	One watt-hour of electricity delivery (1 Wh)	Cradle to Grave
Vandepaer et al. (2019)	Canada	LMP / LFP	Stationary battery	Pyrometallurgical and Hydrometallurgical	Provision of 1 megawatt-hour (MWh) of electricity for the Swiss electricity system by 2030	Cradle to Grave
Cusenza et al. (2019)	Italy	LMO / NMC	LIBs of EV	Pyrometallurgical and Hydrometallurgical	An LMO–NMC battery with a nominal capacity of 11.4 kWh, which provided 136,877 km of driving for a 1860 kg passenger car before battery capacity was reduced by around 81.31%	Cradle to Grave
Raugei & Winfield (2019)	United Kingdom	LCP	LIBs of EV	Hydrometallurgical	A complete battery of 17 kWh (total mass = 108 kg)	Cradle to Gate
Zhao & You (2019)	USA	LMO / NMC	LIBs of EV	Pyrometallurgical and Hydrometallurgical	The production, use, disposal and recycling of 1 (one) battery	Cradle to Grave

Ciez & Whitacre (2019)	USA	NMC / NCA/ LFP	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Direct Cathode Recycling	Use two different functional units: kg of battery manufactured (including cell electrode materials, separators and packaging) and kWh of battery manufactured (including all cell components)	Cradle to Grave
Qiao et al. (2019)	China	NMC	LIBs of EV	Hydrometallurgical	Recycled battery unit	Grave to Gate
Souza et al. (2018)	Brazil	LCO	LIBs of EV	Hydrometallurgical	1 ton of baterries	Cradle to Grave
Bobba et al. (2018)	Italy	LMO / NMC	LIBs of EV	Pyrometallurgical	1 LMO-NMC EV Battery Pack in the recycling	Grave to Gate
Hao et al. (2017)	China	NMC	LIBs of EV	Hydrometallurgical	t of end-of-life EV	Grave to Gate
Bian et al. (2016)	China	LCO	Mobile phones	Pyrometallurgical	1 t of waste mobile phones of different brands and models	Grave to Gate
Sanfélix et al. (2016)	Belgium	LFP	LIBs of EV	Hydrometallurgical	1 battery of 150,000 km lifetime for EV applications	Cradle to Grave
Oliveira et al. (2015)	Belgium	LMO / LFP	LIB of EV	Hydrometallurgical	1000 kg of battery input the system	Cradle to Grave
Hendrickson et al. (2015)	USA	LMO / LFP / NMC	LIBs of EV	Pyrometallurgical and Hydrometallurgical	Plant capacity: 7000 t / year	Cradle to Grave
Dunn et al. (2015)	USA	LMO / LFP / NMC / LCO	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Physical Recycling	1 ton de battery input	Cradle to Grave
Yu et al. (2014)	China	Ni-MH / NMC	LIBs of EV	Recycling or Incineration	One battery whose specific capacity is 1,000 mAh/g	Cradle to Grave
Li et al. (2014)	USA	NMC / LMO / LFP	LIBs of EV	Pyrometallurgical; Hydrometallurgical and Physical Recycling	1 kilometer of EV driving	Cradle to Grave

Swart et al. (2014)	Belgium	NMC/ LCO	LIBs of EV and portable electronics	Pyrometallurgical	kg of cathode material and per kWh of disposable energy during a cycle	Gate to Gate
Gaines et al. (2011)	USA	LCO / LMO / NMC	LIBs of EV	Pyrometallurgical and Hydrometallurgical	Li ion cells (size 18650)	Cradle to Grave

***Legend:** LCO - Lithium Cobalt Oxide (LCO=LiCoO2); NMC - Lithium Nickel Cobalt Manganese Oxide (NMC=LiNixMnyCozO2); LFP - Lithium Iron Phosphate (LFP=LiFePO4), NCA - Lithium Nickel Cobalt Aluminum Oxide (NCA= LiNiCoAlO2); LMO - Lithium manganese oxide (LMO = LiMn2O4); Ni-MH - Nickel–metal hydride battery; LCP - Lithium Cobalt Phosphate (LCP =LiCoPO4).

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SUPPLEMENTARY MATERIAL S2 – Details and mass balance of scenarios

DETRITUS - Detritus – Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

1. SCENARIOS DETAILS

Scenario 1- Pessimistic: reflects the baseline (current) scenario, in which the fraction collected by the RL is lower than that collected informally or mixed with MSW. In this scenario, there are no formal recycling operations for LIBs within Brazil, where recycling activities are limited to disassembly and separation, and the more complex components are exported for recycling abroad, mainly in Europe and Asia (Dias et al., 2018; Duarte Castro et al., 2021). Of the fraction of LIBs collected in smartphones and laptops by formal RL in 2023 (6% according to the Brazilian law) 50% are assumed to be destined for pyrohydrometallurgical recycling abroad (Europe), and the other 50% are destined for hazardous waste landfill in Brazil. Reminder LIBs wastes (94%) are collected informally (50%) or mixed with MSW (50%) and are fully sent to an MSW landfill. Rates of informal collection, mixed in MSW collection and recycling destination (Brazil or Europe) were assumed because data on WEEE management in Brazil are scarce, and there are no data available on the amount of WEEE collected by each of these channels and its destination (Souza et al., 2016; Oliveira Neto et al., 2022). Likewise, there is uncertainty in the LIBs collection rate due to a lack of data (Dunn et al., 2022).

Scenario 2 – Intermediate: the formal RL increases the collection rate to 12% of waste LIBs generated in 2024 (Brazil, 2020), reducing the amount collected informally or discarded with MSW. This scenario assumes that there are LIBs recycling operations in Brazil (hydrometallurgical) in their first steps. 75% of LIBs waste formally collected by RL is sent to recycling abroad, 12.5% to recycling in Brazil and 12.5% to hazardous waste landfill. The assumptions for fractions collected by the informal sector or mixed with MSW are the same as in Scenario 1, with 50 % collected by each route and a full destination to the MSW landfill.

Scenario 3 – Optimistic: RL increases the collection to 17% of LIBS waste in 2025 (Brasil, 2020) and the fraction recycled in Brazil increases. 50% of LIBs waste formally collected by the RL is destined for recycling abroad, 25% for recycling in Brazil, and 25% for the hazardous waste landfill. The assumptions are the same for fractions collected by the informal sector or mixed with MSW (50% collected by each channel and full destination to the MSW landfill).

Scenario 4 - More optimistic: it is assumed that 50% of all LIBs waste is collected by the RL (2026), 25% is collected informally, and 25% is collected mixed with MSW. 75% of LIBs collected by the RL are recycled in Brazil and 25% abroad. In this scenario, a larger fraction of LIBs is recycled in Brazil, significantly reducing their disposal in landfills or sent for recycling abroad.

Although the scenarios designed in this study followed a progressive approach, some assumptions can be considered limitations, such as the amount of waste collected in each collection channel, and the amounts sent outside, can be over or underestimated, due to the lack of consolidated data.

2. MASS BALANCE

Table 1. Mass balance of Scenario 1 (2023).

Scenario 1 - Mass balance (2023)					
Stage	**Flow**	**Smartphones**	**Notebooks**	**Total**	**Description**
Discard	**Discarded mix**	6.493	13.312	19.805	Mass (t) of discarded products (Mix of product waste in units: 89.54% Smartphones / 10.46% Notebooks)
Colllection	**RL (6%)**	390	799	1.188	Mass (t) of complete products collected by RL
	Informal (47%)	3.052	6.256	9.308	Mass (t) of complete products collected by informal
	Mixed with urban waste (47%)	3.052	6.256	9.308	Mass (t) of complete products collected mixed with urban waste
Sorting/ Dismantling	**LIBs**	106	75	181	Mass (t) of batteries: LIBs are 27.3% of the total mass of Smartphones collected and 9.34% of the total mass of Notebooks collected
Recycling	**Abroad (Europe) (50%)**	53	37	**90**	Mass (t) of cells sent abroad for recycling
	Brazil	-	-	-	Scenario 1: There is no recycling in Brazil
Final disposal (27.3% of the total mass of Smartphones collected is LIBs / 9.36% of the total mass of Notebooks collected is LIBs)	**MSW landfill - Informal (100%)**	833,12	584,35	1.417,47	Total mass (t) of cells collected by the informal is sent to MSW landfill
	MSW landfill - Mixed urban waste (100%)	833,12	584,35	1.417,47	Total mass (t) of cells collected mixed with urban waste is sent to MSW landfill
	Hazardous waste landfill - LIBs cells dismanteled (50%)	53	37	90	50% of the mass (t) of cells collected by RL is destined for hazardous waste landfills

	Total sent to landfill (BR)	1.719	1.206	**2.925**	Municipal solid waste {RoW}| treatment of, sanitary landfill | Cut-off, U
Other product components - intended for other recycling chains	e.g. Printed circuit boards/ Cables / Screens	4.437,19	11.344,16	16.789	Not included in system boundary

Table 2. Mass balance of Scenario 2 (2024).

Scenario 2 - Mass balance (2024)					
Stage	**Flow**	**Smartphones**	**Notebooks**	**Total**	**Description**
Discard	**Discarded mix**	6.621	14.248	20.869	Mass (t) of discarded products (Mix of product waste in units: 88,86% Smartphones / 11,14% Notebooks)
Colllection	**RL (12%)**	795	1.710	2.504	Mass (t) of complete products collected by RL
	Informal (44%)	2.913	6.269	9.182	Mass (t) of complete products collected by informal
	Mixed with urban waste (44%)	2.913	6.269	9.182	Mass (t) of complete products collected mixed with urban waste
Sorting/ Dismantling	**LIBs**	217	160	377	Mass (t) of batteries: LIBs are 27.3% of the total mass of Smartphones collected and 9.34% of the total mass of Notebooks collected
Recycling	**Abroad (Europe) (75%)**	163	120	**282**	Mass (t) of cells sent abroad for recycling
	Brazil (12,5%)	27,1	20,0	**47,1**	Mass (t) of cells recycled in Brazil
Final disposal (27.3% of the total mass of Smartphones collected is LIBs / 9.36% of the total mass of	**MSW landfill - Informal (100%)**	795,31	585,52	1.380,83	Total mass (t) of cells collected by the informal is sent to MSW landfill
	MSW landfill - Mixed urban waste (100%)	795,31	585,52	1.380,83	Total mass (t) of cells collected mixed with urban waste is sent to MSW landfill

Notebooks collected is LIBs)	**Hazardous waste landfill - LIBs cells dismanteled (12,5%)**	27,1	20,0	47,1	12,5% of the mass (t) of cells collected by RL is destined for hazardous waste landfills
	Total sent to landfill (BR)	1.618	1.191	**2.809**	Municipal solid waste {RoW}| treatment of, sanitary landfill | Cut-off, U
Other product components - intended for other recycling chains	e.g. Printed circuit boards/ Cables / Screens	4.235,85	11.366,80	17.730	Not included in system boundary

Table 3. Mass balance of Scenario 3 (2025).

Scenario 3 - Mass balance (2025)					
Stage	**Flow**	**Smartphones**	**Notebooks**	**Total**	**Description**
Discard	**Discarded mix**	6.587	14.937	21.524	Mass (t) of discarded products (Mix of product waste in units: 88,86% Smartphones / 11,14% Notebooks)
Colllection	**RL (17%)**	1.120	2.539	3.659	Mass (t) of complete products collected by RL
	Informal (41,5%)	2.734	6.199	8.932	Mass (t) of complete products collected by informal
	Mixed with urban waste (41,5%)	2.734	6.199	8.932	Mass (t) of complete products collected mixed with urban waste
Sorting/ Dismantling	**LIBs**	306	237	543	Mass (t) of batteries: LIBs are 27.3% of the total mass of Smartphones collected and 9.34% of the total mass of Notebooks collected
Recycling	**Abroad (Europe) (50%)**	153	119	**271**	Mass (t) of cells sent abroad for recycling
	Brazil (25%)	76,4	59,3	**135,7**	Mass (t) of cells recycled in Brazil

	MSW landfill - Informal (100%)	746,27	578,95	1.325,23	Total mass (t) of cells collected by the informal is sent to MSW landfill
Final disposal (27.3% of the total mass of Smartphones collected is LIBs / 9.36% of the total mass of Notebooks collected is LIBs)	**MSW landfill - Mixed urban waste (100%)**	746,27	578,95	1.325,23	Total mass (t) of cells collected mixed with urban waste is sent to MSW landfill
	Hazardous waste landfill - LIBs cells dismanteled (25%)	76,4	59,3	135,7	25% of the mass (t) of cells collected by RL is destined for hazardous waste landfills
	Total sent to landfill (BR)	1.569	1.217	**2.786**	Municipal solid waste {RoW}| treatment of, sanitary landfill | Cut-off, U
Other product components - sent for other recycling chains	e.g. Printed circuit boards/ Cables / Screens	3.974,66	11.239,40	18.330	Not included in system boundary

Table 4. Mass balance of Scenario 4 (2026).

Scenario 4 - Mass balance (2026)					
Stage	**Flow**	**Smartphones**	**Notebooks**	**Total**	**Description**
Discard	**Discarded mix**	6.548	16.047	22.595	Mass (t) of discarded products (Mix of product waste in units: 88,86% Smartphones / 11,14% Notebooks)
	RL (50%)	3.274	8.023	11.297	Mass (t) of complete products collected by RL
Colllection	**Informal (25%)**	1.637	4.012	5.649	Mass (t) of complete products collected by informal
	Mixed with urban waste (25%)	1.637	4.012	5.649	Mass (t) of complete products collected mixed with urban waste
Sorting/ Dismantling	**LIBs**	894	749	1.643	Mass (t) of batteries: LIBs are 27.3% of the total mass of Smartphones collected and 9.34% of the total mass of Notebooks collected
Recycling	**Abroad (Europe) (25%)**	223	187	**411**	Mass (t) of cells sent abroad for recycling

	Brazil (75%)	670,4	562,0	**1.232,4**	Mass (t) of cells recycled in Brazil
Final disposal (27.3% of the total mass of Smartphones collected is LIBs / 9.36% of the total mass of Notebooks collected is LIBs)	**MSW landfill - Informal (100%)**	446,90	374,69	821,59	Total mass (t) of cells collected by the informal is sent to MSW landfill
	MSW landfill - Mixed urban waste (100%)	446,90	374,69	821,59	Total mass (t) of cells collected mixed with urban waste is sent to MSW landfill
	Hazardous waste landfill - LIBs cells dismanteled (0%)	0	0	0	In scenario 4, all LIBs collected by LR are destined for recycling
	Total sent to landfill (BR)	894	749	**1.643**	Municipal solid waste {RoW}| treatment of, sanitary landfill | Cut-off, U
Other product components - sent for other recycling chains	e.g. Printed circuit boards/ Cables / Screens	2.380,20	7.274,02	19.308	Not included in system boundary

SUPPLEMENTARY MATERIAL 3 - Estimated LIBs waste from smartphones and laptops

DETRITUS - Detritus – Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

1. Calculation method and results of estimating Smartphones and Notebooks waste generation in unit and mass per year
2. Results of the estimated LIB waste generation in streams of discarded Smartphones and Notebooks per year in Brazil

Lifespan distribution (Abbondanza; Souza (2019)

Smartphones

Year	Probability
1	35,90%
2	52,65%
3	6,09%
4	2,33%
5	2,43%
6	0,20%
7	0,20%
8	0,20%

Year	Smartphones sales / units by year (millions of units) (ABINEE, 2022)	Average weight Smartphones (kg)
2012	9.485.367	0,15454
2013	35.194.688	
2014	54.551.235	
2015	47.232.690	
2016	43.494.450	
2017	47.704.380	
2018	44.453.584	
2019	45.413.193	
2020	42.315.072	
2021	40.998.000	
2022	43.004.150	
2023	42.734.565	
2024	42.464.980	
2025	42.195.395	

Year	Smartphones sales / units by year (millions of units) (ABINEE, 2022)	Average weight Smartphones (kg)	Total mass
2012	9.485.367	0,15454	1.465.868,62
2013	35.194.688	0,15454	5.438.987,08
2014	54.551.235	0,15454	8.430.347,86
2015	47.232.690	0,15454	7.299.339,91
2016	43.494.450	0,15454	6.721.632,30
2017	47.704.380	0,15454	7.372.234,89
2018	44.453.584	0,15454	6.869.856,92
2019	45.413.193	0,15454	7.018.154,91
2020	42.315.072	0,15454	6.539.371,26
2021	40.998.000	0,15454	6.335.830,92
2022	43.004.150,0	0,15454	6.645.861,34
2023	42.734.565,0	0,15454	6.604.199,68
2024	42.464.980,0	0,15454	6.562.538,01
2025	42.195.395,0	0,15454	6.520.876,34

Smartphone waste generation estimate

Discard year	Smartphone purchase year														(Unity)	Discard year		1,55E-01	
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			Mass (kg)	Mass (t)	
2013	3,41E+06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3.405.246,75	2013	5,26E+05	5,26E+02	
2014	4,99E+06	1,26E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	17.628.938,72	2014	2,72E+06	2,72E+03	
2015	5,78E+05	1,85E+07	1,96E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	38.691.555,45	2015	5,98E+06	5,98E+03	
2016	2,21E+05	2,14E+06	2,87E+07	1,70E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	48.042.126,49	2016	7,42E+06	7,42E+03	
2017	2,30E+05	8,20E+05	3,32E+06	2,49E+07	1,56E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	44.855.219,70	2017	6,93E+06	6,93E+03	
2018	1,90E+04	8,55E+05	1,27E+06	2,88E+06	2,29E+07	1,71E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	45.047.416,59	2018	6,96E+06	6,96E+03	
2019	1,90E+04	7,04E+04	1,33E+06	1,10E+06	2,65E+06	2,51E+07	1,60E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	46.239.481,64	2019	7,15E+06	7,15E+03	
2020	1,90E+04	7,04E+04	1,09E+05	1,15E+06	1,01E+06	2,91E+06	2,34E+07	1,63E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	44.972.982,94	2020	6,95E+06	6,95E+03	
2021	0,00E+00	7,04E+04	1,09E+05	9,45E+04	1,06E+06	1,11E+06	2,71E+06	2,39E+07	1,52E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	44.250.764,94	2021	6,84E+06	6,84E+03	
2022	0,00E+00	0,00E+00	1,09E+05	9,45E+04	8,70E+04	1,16E+06	1,04E+06	2,77E+06	2,23E+07	1,47E+07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	42.248.372,69	2022	6,53E+06	6,53E+03	
2023	0,00E+00	0,00E+00	0,00E+00	9,45E+04	8,70E+04	9,54E+04	1,08E+06	1,06E+06	2,58E+06	2,16E+07	1,54E+07	0,00E+00	0,00E+00	0,00E+00	42.016.137,29	2023	6,49E+06	6,49E+03	Input data for Scenario modelling
2024	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,70E+04	9,54E+04	8,89E+04	1,10E+06	9,86E+05	2,50E+06	2,26E+07	1,53E+07	0,00E+00	0,00E+00	42.840.958,62	2024	6,62E+06	6,62E+03	
2025	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,54E+04	8,89E+04	9,08E+04	1,03E+06	9,55E+05	2,62E+06	2,25E+07	1,52E+07	0,00E+00	42.622.281,00	2025	6,59E+06	6,59E+03	
2026	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,89E+04	9,08E+04	8,46E+04	9,96E+05	1,00E+06	2,60E+06	2,24E+07	1,51E+07	42.371.105,58	2026	6,55E+06	6,55E+03	
2027	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,08E+04	8,46E+04	8,20E+04	1,05E+06	9,96E+05	2,59E+06	2,22E+07	27.100.161,49	2027	4,19E+06	4,19E+03	
2028	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,46E+04	8,20E+04	8,60E+04	1,04E+06	9,89E+05	2,57E+06	4.850.217,96	2028	7,50E+05	7,50E+02	
2029	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,20E+04	8,60E+04	8,55E+04	1,03E+06	9,83E+05	2.268.525,15	2029	3,51E+05	3,51E+02	
2030	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,60E+04	8,55E+04	8,49E+04	1,03E+06	1.281.755,49	2030	1,98E+05	1,98E+02	
2031	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,55E+04	8,49E+04	8,44E+04	254.789,88	2031	3,94E+04	3,94E+01	
2032	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,49E+04	8,44E+04	169.320,75	2032	2,62E+04	2,62E+01	
2033	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,44E+04	84.390,79	2033	1,30E+04	1,30E+01	

Lifespan distribution (Abbondanza; Souza (2019)	
Laptops	
Year	Probability
1	7,00%
2	14,00%
3	25,00%
4	12,00%
5	16,00%
6	9,00%
7	3,00%
8	7,00%
9	7,00%

Year	Laptops sales (ABINEE, 2022)	Average weight laptops(kg)	Total mass
2012	8.931.952,00	2,711	24.214.521,87
2013	8.196.429,00	2,711	22.220.519,02
2014	6.360.957,00	2,711	17.244.554,43
2015	4.050.343,00	2,711	10.980.479,87
2016	2.844.954,00	2,711	7.712.670,29
2017	3.453.372,00	2,711	9.362.091,49
2018	3.935.760,00	2,711	10.669.845,36
2019	4.125.590,00	2,711	11.184.474,49
2020	5.025.386,00	2,711	13.623.821,45
2021	6.798.000,00	2,711	18.429.378,00
2022	6.462.817,38	2,711	17.520.697,93
2023	6.393.298,03	2,711	17.332.230,95
2024	6.410.677,87	2,711	17.379.347,70
2025	6.668.892,62	2,711	18.079.367,90

Notebooks waste generation estimate

Discard year	Ano de compra														(Unity)	Mass (Notebooks)	Discard Year	2,711	
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025		Mass (kg)		Mass (t)	
2013	6,25E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	625.236,64	1,70E+06	2013	1.695	
2014	1,25E+06	5,74E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1.824.223,31	4,95E+06	2014	4.945	
2015	2,23E+06	1,15E+06	4,45E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3.825.755,05	1,04E+07	2015	10.372	
2016	1,07E+06	2,05E+06	8,91E+05	2,84E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4.294.999,48	1,16E+07	2016	11.644	
2017	1,43E+06	9,84E+05	1,59E+06	5,67E+05	1,99E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4.769.117,85	1,29E+07	2017	12.929	
2018	8,04E+05	1,31E+06	7,63E+05	1,01E+06	3,98E+05	2,42E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4.531.234,51	1,23E+07	2018	12.284	
2019	2,68E+05	7,38E+05	1,02E+06	4,86E+05	7,11E+05	4,83E+05	2,76E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3.979.645,23	1,08E+07	2019	10.789	
2020	6,25E+05	2,46E+05	5,72E+05	6,48E+05	3,41E+05	8,63E+05	5,51E+05	2,89E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4.136.205,70	1,12E+07	2020	11.213	
2021	6,25E+05	5,74E+05	1,91E+05	3,65E+05	4,55E+05	4,14E+05	9,84E+05	5,78E+05	3,52E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4.537.243,15	1,23E+07	2021	12.300	
2022	0,00E+00	5,74E+05	4,45E+05	1,22E+05	2,56E+05	5,53E+05	4,72E+05	1,03E+06	7,04E+05	4,76E+05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4.632.215,43	1,26E+07	2022	12.558	
2023	0,00E+00	0,00E+00	4,45E+05	2,84E+05	8,53E+04	3,11E+05	6,30E+05	4,95E+05	1,26E+06	9,52E+05	4,52E+05	0,00E+00	0,00E+00	0,00E+00	4.910.199,22	1,33E+07	2023	13.312	Input data for Scenario modelling
2024	0,00E+00	0,00E+00	0,00E+00	2,84E+05	1,99E+05	1,04E+05	3,54E+05	6,60E+05	6,03E+05	1,70E+06	9,05E+05	4,48E+05	0,00E+00	0,00E+00	5.255.456,37	1,42E+07	2024	14.248	
2025	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,99E+05	2,42E+05	1,18E+05	3,71E+05	8,04E+05	8,16E+05	1,62E+06	8,95E+05	4,49E+05	0,00E+00	5.509.594,00	1,49E+07	2025	14.937	
2026	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,42E+05	2,76E+05	1,24E+05	4,52E+05	1,09E+06	7,76E+05	1,60E+06	8,97E+05	4,67E+05	5.919.151,66	1,60E+07	2026	16.047	
2027	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,76E+05	2,89E+05	1,51E+05	6,12E+05	1,03E+06	7,67E+05	1,60E+06	9,34E+05	5.664.437,06	1,54E+07	2027	15.356	
2028	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,89E+05	3,52E+05	2,04E+05	5,82E+05	1,02E+06	7,69E+05	1,67E+06	4.885.594,07	1,32E+07	2028	13.245	
2029	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,52E+05	4,76E+05	1,94E+05	5,75E+05	1,03E+06	8,00E+05	3.422.893,94	9,28E+06	2029	9.279	
2030	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,76E+05	4,52E+05	1,92E+05	5,77E+05	1,07E+06	2.764.039,99	7,49E+06	2030	7.493	
2031	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,52E+05	4,48E+05	1,92E+05	6,00E+05	1.692.448,75	4,59E+06	2031	4.588	
2032	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,48E+05	4,49E+05	2,00E+05	1.096.345,09	2,97E+06	2032	2.972	
2033	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,49E+05	4,67E+05	915.569,93	2,48E+06	2033	2.482	
2034	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,67E+05	466.822,48	1,27E+06	2034	1.266	

Lifespan distribution (Abbondanza; Souza (2019)	
Year	Probability
1	35,90%
2	52,65%
3	6,09%
4	2,33%
5	2,43%
6	0,20%
7	0,20%
8	0,20%

Year	Smartphones sales / units by year (millions of units) (ABINEE, 2022)	Average weight LIBs(kg)
2012	9.485.367	0,0422
2013	35.194.688	
2014	54.551.235	
2015	47.232.690	
2016	43.494.450	
2017	47.704.380	
2018	44.453.584	
2019	45.413.193	
2020	42.315.072	
2021	40.998.000	
2022	43.004.150	
2023	42.734.565	
2024	42.464.980	
2025	42.195.395	

Year	Smartphones sales / units by year (millions of units) (ABINEE, 2022)	Average weight LIBs in Smartphones (kg)	Total mass - LIBs (kg)	Total mass Smartphones (kg)	% LIB in Smartphone
2012	9.485.367	0,0422	400.282,49	1.465.868,62	27,31%
2013	35.194.688	0,0422	1.485.215,83	5.438.987,08	27,31%
2014	54.551.235	0,0422	2.302.062,12	8.430.347,86	27,31%
2015	47.232.690	0,0422	1.993.219,52	7.299.339,91	27,31%
2016	43.494.450	0,0422	1.835.465,79	6.721.632,30	27,31%
2017	47.704.380	0,0422	2.013.124,84	7.372.234,89	27,31%
2018	44.453.584	0,0422	1.875.941,26	6.869.856,92	27,31%
2019	45.413.193	0,0422	1.916.436,76	7.018.154,91	27,31%
2020	42.315.072	0,0422	1.785.696,05	6.539.371,26	27,31%
2021	40.998.000	0,0422	1.730.115,60	6.335.830,92	27,31%
2022	43.004.150,00	0,0422	1.814.775,13	6.645.861,34	27,31%
2023	42.734.565,00	0,0422	1.803.398,64	6.604.199,68	27,31%
2024	42.464.980,00	0,0422	1.792.022,16	6.562.538,01	27,31%
2025	42.195.395,00	0,0422	1.780.645,67	6.520.876,34	27,31%

Discard year	Smartphone purchase year														LIBs waste generation - Smartphones/year (kg)	Discard year	**Mass (t)**
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
2013	143.701,41	0	0	0	0	0	0	0	0	0	0	0	0	0	143.701	2013	144
2014	210.748,73	533.192	0	0	0	0	0	0	0	0	0	0	0	0	743.941	2014	744
2015	24.377,20	781.966	826.440,30	0	0	0	0	0	0	0	0	0	0	0	1.632.784	2015	1.633
2016	9.326,58	90.450	1.212.035,70	715.565,81	0	0	0	0	0	0	0	0	0	0	2.027.378	2016	2.027
2017	9.726,86	34.606	140.195,58	1.049.430,08	658.932,22	0	0	0	0	0	0	0	0	0	1.892.890	2017	1.893
2018	800,56	36.091	53.638,05	121.387,07	966.372,74	722.711,82	0	0	0	0	0	0	0	0	1.901.001	2018	1.901
2019	800,56	2.970	55.940,11	46.442,01	111.779,87	1.059.910,23	673.462,91	0	0	0	0	0	0	0	1.951.306	2019	1.951
2020	800,56	2.970	4.604,12	48.435,23	42.766,35	122.599,30	987.683,07	688.000,80	0	0	0	0	0	0	1.897.860	2020	1.898
2021	0	2.970	4.604,12	3.986,44	44.601,82	46.905,81	114.244,82	1.009.003,95	641.064,88	0	0	0	0	0	1.867.382	2021	1.867
2022	0	0	4.604,12	3.986,44	3.670,93	48.918,93	43.709,43	116.711,00	940.168,97	621.111,50	0	0	0	0	1.782.881	2022	1.783
2023	0	0	0	3.986,44	3.670,93	4.026,25	45.585,37	44.652,98	108.748,89	910.905,86	651.504,27	0	0	0	1.773.081	2023	1.773
2024	0	0	0	0	3.670,93	4.026,25	3.751,88	46.569,41	41.606,72	105.364,04	955.479,11	647.420,11	0	0	1.807.888	2024	1.808
2025	0	0	0	0	0	4.026,25	3.751,88	3.832,87	43.392,41	40.311,69	110.519,81	949.489,39	643.335,95	0	1.798.660	2025	1.799
2026	0	0	0	0	0	0	3.751,88	3.832,87	3.571,39	42.041,81	42.284,26	109.826,98	943.499,67	639.251,80	1.788.061	2026	1.788
2027	0	0	0	0	0	0	0	3.832,87	3.571,39	3.460,23	44.099,04	42.019,19	109.134,15	937.509,94	1.143.627	2027	1.144
2028	0	0	0	0	0	0	0	0	3.571,39	3.460,23	3.629,55	43.822,59	41.754,12	108.441,32	204.679	2028	205
2029	0	0	0	0	0	0	0	0	0	3.460,23	3.629,55	3.606,80	43.546,14	41.489,04	95.732	2029	96
2030	0	0	0	0	0	0	0	0	0	0	3.629,55	3.606,80	3.584,04	43.269,69	54.090	2030	54
2031	0	0	0	0	0	0	0	0	0	0	0	3.606,80	3.584,04	3.561,29	10.752	2031	11
2032	0	0	0	0	0	0	0	0	0	0	0	0	3.584,04	3.561,29	7.145	2032	7,1
2033	0	0	0	0	0	0	0	0	0	0	0	0	0	3.561,29	3.561	2033	3,6

Lifespan distribution (Abbondanza; Souza (2019)	
Notebooks	
Year	Probability
1	7,00%
2	14,00%
3	25,00%
4	12,00%
5	16,00%
6	9,00%
7	3,00%
8	7,00%
9	7,00%

Year	Notebooks sales	Average weight LIBs in Notebooks (kg)	Total mass - LIBs	Total mass notebook	% weight LIBs in Notebooks
2012	8.931.952,00	0,2532	2.261.570,25	24.214.521,87	9,34%
2013	8.196.429,00	0,2532	2.075.335,82	22.220.519,02	9,34%
2014	6.360.957,00	0,2532	1.610.594,31	17.244.554,43	9,34%
2015	4.050.343,00	0,2532	1.025.546,85	10.980.479,87	9,34%
2016	2.844.954,00	0,2532	720.342,35	7.712.670,29	9,34%
2017	3.453.372,00	0,2532	874.393,79	9.362.091,49	9,34%
2018	3.935.760,00	0,2532	996.534,43	10.669.845,36	9,34%
2019	4.125.590,00	0,2532	1.044.599,39	11.184.474,49	9,34%
2020	5.025.386,00	0,2532	1.272.427,74	13.623.821,45	9,34%
2021	6.798.000,00	0,2532	1.721.253,60	18.429.378,00	9,34%
2022	6.462.817,38	0,2532	1.636.385,36	17.520.697,93	9,34%
2023	6.393.298,03	0,2532	1.618.783,06	17.332.230,95	9,34%
2024	6.410.677,87	0,2532	1.623.183,64	17.379.347,70	9,34%

Discard year	Notebooks purchase year														LIBs waste generation - Notebooks/year (Kg)	Discard year	LIBs mass in Notebooks (t)	9,34%
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			t	
2013	40.084,07	0	0	0	0	0	0	0	0	0	0	0	0	0	40.084,07	2013	158,31	
2014	80.168,14	40.084	0	0	0	0	0	0	0	0	0	0	0	0	120.252,21	2014	461,89	
2015	143.157,40	80.168	40.084,07	0	0	0	0	0	0	0	0	0	0	0	263.409,61	2015	968,68	
2016	68.715,55	143.157	80.168,14	40.084,07	0	0	0	0	0	0	0	0	0	0	332.125,16	2016	1.087,49	
2017	91.620,73	68.716	143.157,40	80.168,14	40.084,07	0	0	0	0	0	0	0	0	0	423.745,89	2017	1.207,54	
2018	51.536,66	91.621	68.715,55	143.157,40	80.168,14	40.084,07	0	0	0	0	0	0	0	0	475.282,56	2018	1.147,31	
2019	17.178,89	51.537	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	0	0	0	0	0	0	492.461,44	2019	1.007,65	
2020	40.084,07	17.179	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	0	0	0	0	0	532.545,52	2020	1.047,29	
2021	40.084,07	40.084	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	0	0	0	0	572.629,59	2021	1.148,83	
2022	0	40.084	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	0	0	0	572.629,59	2022	1.172,88	
2023	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	0	0	572.629,59	2023	1.243,26	
2024	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	0	572.629,59	2024	1.330,68	
2025	0	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	40.084,07	0	572.629,59	2025	1.395,03	
2026	0	0	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	80.168,14	0,00	532.545,52	2026	1.498,73	
2027	0	0	0	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	143.157,40	0,00	452.377,37	2027	1.434,24	
2028	0	0	0	0	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	68.715,55	0,00	309.219,98	2028	1.237,03	
2029	0	0	0	0	0	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	91.620,73	0,00	240.504,43	2029	866,68	
2030	0	0	0	0	0	0	0	0	0	40.084,07	40.084,07	17.178,89	51.536,66	0,00	148.883,69	2030	699,85	
2031	0	0	0	0	0	0	0	0	0	0	40.084,07	40.084,07	17.178,89	0,00	97.347,03	2031	428,53	
2032	0	0	0	0	0	0	0	0	0	0	0	40.084,07	40.084,07	0,00	80.168,14	2032	277,59	
2033	0	0	0	0	0	0	0	0	0	0	0	0	40.084,07	0,00	40.084,07	2033	231,82	
2034	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00	0,00	2034	118,20	

			Sales forecast			
Period	Year	Number of smartphones sold	Logarithmic Trend(R2=0,768)	Error Ln	Absolute error	Variation %
1	2013	35.194.688	52.700.000	-17.505.312,00	17.505.312,00	33,22%
2	2014	54.551.235	49.054.046	5.497.189,17	5.497.189,17	11,21%
3	2015	47.232.690	46.921.299	311.390,64	311.390,64	0,66%
4	2016	43.494.450	45.408.092	-1.913.641,66	1.913.641,66	4,21%
5	2017	47.704.380	44.234.357	3.470.023,42	3.470.023,42	7,84%
6	2018	44.453.584	43.275.345	1.178.239,11	1.178.239,11	2,72%
7	2019	45.413.193	42.464.513	2.948.680,78	2.948.680,78	6,94%
8	2020	42.315.072	41.762.137	552.934,71	552.934,71	1,32%
9	2021	40.998.000	41.142.599	-144.598,72	144.598,72	0,35%
10	2022	Forecast	43.004.150		Average variation	7,61%
11	2023	Forecast	42.734.565			
12	2024	Forecast	42.464.980			
13	2025	Forecast	42.195.395			

Period	Year	Number of Notebooks sold	Source
1	2012	8.931.952,00	ABINEE (2022)
2	2013	8.196.429,00	ABINEE (2022)
3	2014	6.360.957,00	ABINEE (2022)
4	2015	4.050.343,00	ABINEE (2022)
5	2016	2.844.954,00	ABINEE (2022)
6	2017	3.453.372,00	ABINEE (2022)
7	2018	3.935.760,00	ABINEE (2022)
8	2019	4.125.590,00	ABINEE (2022)
9	2020	5.025.386,00	ABINEE (2022)
10	2021	6.798.000,00	ABINEE (2022)
11	2022	6.462.817	Forecast - Estimated using variation (%) of global sales projection provided for Statista (2022)
12	2023	6.393.298	Forecast - Estimated using variation (%) of global sales projection provided for Statista (2022)
13	2024	6.410.678	Forecast - Estimated using variation (%) of global sales projection provided for Statista (2022)
14	2025	6.668.893	Forecast - Estimated using variation (%) of global sales projection provided for Statista (2022)

Statista data - Global Sales Projections for Notebooks

Year	Units of Smartphones sold worldwide (in millions of units)	Variation (%)	Variation (Unity)	Absolute value	Source	
2021	273,8				Statista (2022)	
2022	260,3	-4,93%	-335.182,62	335.182,62	Statista (2022)	https://www.statista.com/statistics/269048/worldwide-portable-pc-shipment-forecast/
2023	257,5	-1,08%	-69.519,36	69.519,36	Statista (2022)	
2024	258,2	0,27%	17.379,84	17.379,84	Statista (2022)	
2025	268,6	4,03%	258.214,76	258.214,76	Statista (2022)	

SUPPLEMENTARY MATERIAL 4 – Function, Functional Units, and Reference flow for Scenarios and recycling Technologies

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Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Table 1 - Function, Functional Unit, and Reference Flow for Scenarios.

Scenarios assessment	
Function	Environmentally appropriate disposal of waste Lithium Ion Batteries (LIBs) from the mix of Notebooks and Smartphones discarded at Reverse Logistics.
Functional Unit – **Scenarios (Sc)**	Treatment of LIBs from mix of Smartphones and Notebooks discarded in Brazil in a period of 1 year.
Reference Flow - Sc1	181 t of LIBs waste generated in 2023 entering the system for treatment.
Reference Flow - Sc2	377 t of LIBs waste generated in 2024 entering the system for treatment.
Reference Flow - Sc3	543 t of LIBs waste generated in 2025 entering the system for treatment.
Reference Flow - Sc4	1.643 t of LIBs waste generated in 2026 entering the system for treatment.
Evaluation of Hydrometallurgical (Brazil) and Pyrohydrometallurgical (Europe) recycling processes	
Functional Unit - Recycling technologies	Treatment of 1 t of LIBs waste from the mix of Smartphones and Notebooks.
Reference Flow	1 t of LIBs entering the system for treatment

SUPPLEMENTARY MATERIAL 5 – Substitution assumptions

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Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Table 1. Process substitution in Hydrometallurgical recycling in Brazil.

Brazil	
Hydrometallurgical process with pre-treatment	
Input	1 t of LIBs cells
Product output	kg/t
Cobalt	112
Nickel	28,2
Manganese	18,7
Iron	10
Lithium carbonate	18,66
Graphite	252
Inventory process of avoided products (Assumed substitution 1:1)	
Cobalt	Cobalt {GLO}| production | Cut-off, U
Nickel	Nickel, 99.5% {GLO}| nickel mine operation, sulfidic ore | Cut-off, U
Manganese	Manganese {RoW}| production | Cut-off, U
Iron	Iron ore, beneficiated, 65% Fe {RoW}| iron ore beneficiation to 65% Fe | Cut-off, U
Lithium carbonate	Lithium carbonate {GLO}| production, from concentrated brine | Cut-off, U
Graphite	Graphite {RoW}| production | Cut-off, U

Table 2. Process substitution in Pyrohydrometallurgical recycling in Europe.

Europe	
Pyrohydrometallurgical process	Fisher et al. inventory, 2006 (Ecoinvent) - Pyrometallurgical: Edited to include the subsequent hydrometallurgical step. Manganese was replaced by nickel to better reflect the current situation. Data on recovery rate of alloyed metals were taken from Rajaeifar et al. (2021).
Input	1 t of LIBs cells entering in smelting
Product output	kg/t
Iron	40,1
Copper	84
Cobal	63,9
Nickel	63,9
Pyrohydrometallurgical recycling inventory	
Inventories used for recycling abroad. The original was modified to include the hydrometallurgical inventory	Used Li-ion battery {GLO}| treatment of used Li-ion battery, pyrometallurgical treatment | Cut-off, U EDITED[BR]_Used Li-ion battery {GLO}| treatment of used Li-ion battery, hydrometallurgical treatment | Cut-off, U
Inventory process of avoided products (Assumed substitution 1:1)	
Iron	Iron ore, beneficiated, 65% Fe {RoW}| iron ore beneficiation to 65% Fe | Cut-off, U
Copper	Copper {RoW}| production, primary | Cut-off, U
Cobal	Cobalt {GLO}| production | Cut-off, U
Nickel	Nickel, 99.5% {GLO}| nickel mine operation, sulfidic ore | Cut-off, U

Cut-off definition

Inventories in the "cut off" system model that recyclable materials are distributed to subsequent processes without charge, however, the charges for treatment activities (such as landfill or recycling) are allocated to the activity generating the waste (Wernet et al., 2016).

According to Ecoinvent explanation, the "Allocation, cut-off by sorting" system model, or cut-off system model, is based on the recycled content approach, or cut-off. In this system model, waste is the responsibility of the producer, and there is an incentive to use recyclable products, which are available free of charge (cut-off). Waste by-products have to be treated and the treatment burden is fully attributed to the waste generation activity. Waste is therefore linked as a negative input to the activity, representing the fact that the activity needs the waste disposal service. Waste disposal is then provided by different treatment processes, which have inputs and emissions that increase the burden on the waste-producing activity (Ecoinvent, 2023). In practical terms, inventories modeled in cut off include the charges for waste treatment processes within the processes that generate the waste, but the usable product is supplied without any charges.

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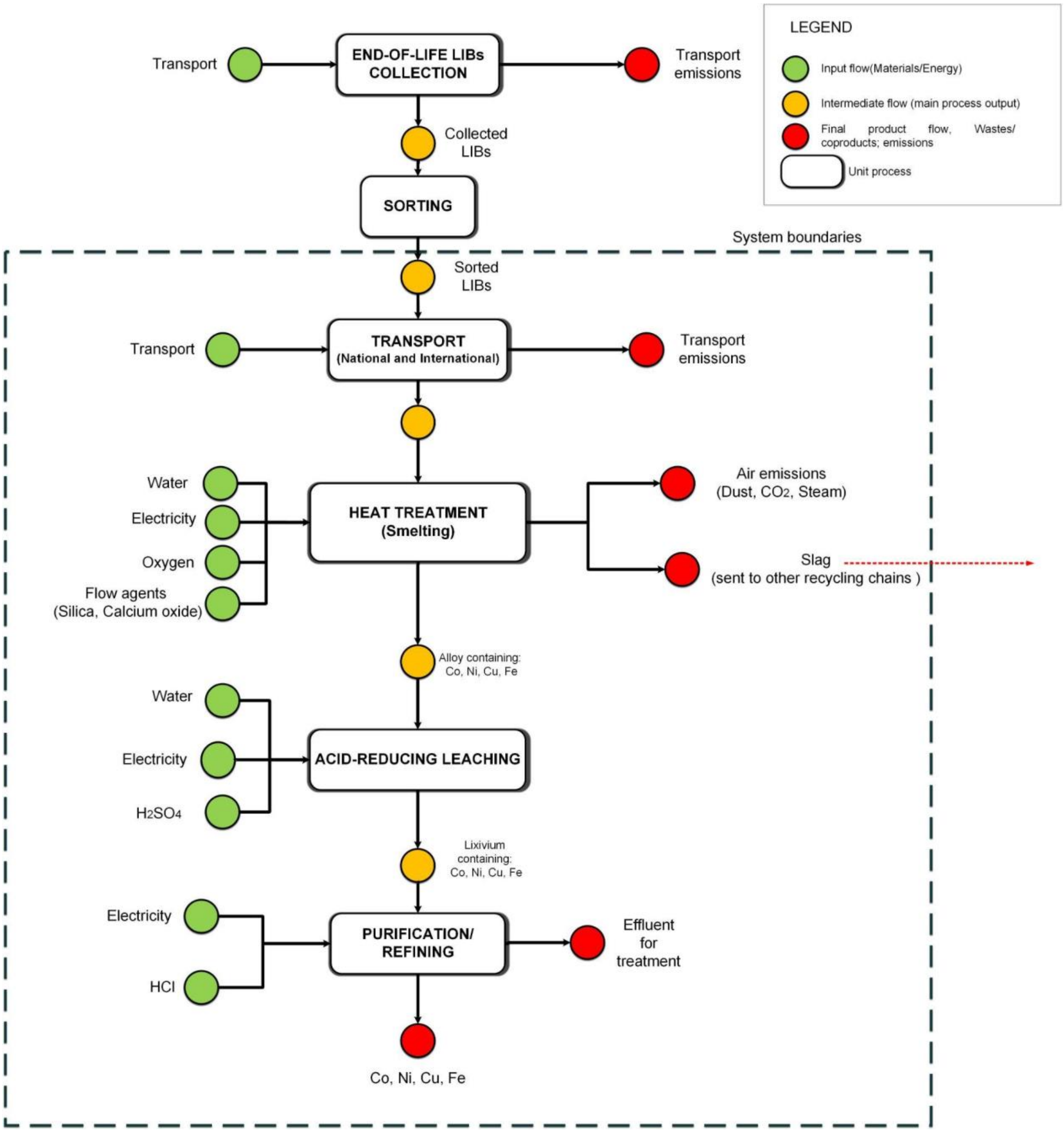
SUPPLEMENTARY MATERIAL 6 – Flowchart and processes description of pyrohydrometallurgical recycling in Europe

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

The pyrohydrometallurgical process for recycling abroad (Europe) is modelled using Ecoinvent inventories and updated data from the literature. The European pyrohydrometallurgical process begins with the national and international transports of sorted cells and the receipt of LIBs at the recycling plant. Next, the cells are heat-treated through a blast furnace casting process. Furnace products consist of alloys and slag that are sent for further treatment. The alloys are sent to a hydrometallurgical process that uses inorganic chemical reagents, in this case, sulfuric acid for leaching and hydrochloric acid for the recovery of metals. Metal recovery efficiencies were adapted from Rajaeifar et al. (2021), that is, 99.98% for cobalt, 99.98% for nickel, 100% for copper and 97.8% for iron.

Figure 1. Product system and system boundary for LIBs pyrohydrometallurgical recycling abroad.



SUPPLEMENTARY MATERIAL S7 – Stoichiometry

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: Life Cycle Assessment of end-of-life lithium-ion batteries from smartphones and laptops: case in Brazil

1 LEACH REACTION

The reaction stoichiometry of the cathode powder with sulfuric acid and glucose is given by Eq. (1). The most popular and widely used material in lithium-ion batteries is the $LiNi_{0.33}Mn_{0.33}Co_{0.33}O_2$ (NMC) phase (approx. 30% of each metal) (Zhang et al., 2010; Sieber et al., 2019). Lithium-nickel-manganese-cobalt oxide (LiNiMnCoO2) reacts with sulfuric acid and glucose, producing sulfates of each metal, water and carbon dioxide. Glucose is fully oxidized into CO2 and water (Pagnanelli et al., 2017).

$$\mathbf{20}LiNi_{0.3}Mn_{0.3}Co_{0.3}O_2 + \mathbf{28}H_2SO_4 + C_6H_{12}O_6 \rightarrow \mathbf{6}NiSO_4 + \mathbf{10}Li2SO_4 + \mathbf{6}MnSO_4 + \mathbf{6}CoSO_4 + \mathbf{34}H_2O + \mathbf{6}CO_2 \quad (1)$$

1.1 Iron

The reaction of Fe with sulfuric acid produces iron sulfate ($FeSO_4$) Eq. (2).

$$Fe + \mathbf{3}H_2SO_4 \rightarrow Fe\ (SO_4)_3 + \mathbf{6}H \quad (2)$$

Precipitation of iron sulfate with sodium hydroxide produces iron III hydroxide and sodium sulfate. With NaOH, 100% of the Fe is precipitated from the leach solution Eq. (3).

$$Fe\ (SO4)3 + \mathbf{3}NaOH \rightarrow Fe(OH)3 + \mathbf{3}Na_2SO_4 \quad (3)$$

Dehydration of iron III hydroxide produces hematite and water in vapour Eq. (4).

$$Fe(OH)_3 \rightarrow Fe_2O_3(s) + \mathbf{3}H_2O(g) \quad (4)$$

To precipitate the amount of Fe (20g/kg- 0.36M) the amount of 43.18 g of NaOH (1.08M) is required. Some impurities such as Cu and Al are precipitated together with Fe_2O_3 - the content of these metals in the fine fraction of the cathode material is low.

1.2 Hydroxides

Reaction of the metals with sulfuric acid produces sulfates of each metal Eq. (5), Eq. (6), Eq. (7). The co-precipitation of the three metals is done with NaOH which results in the precipitation of hydroxides and sodium sulfate. Each mole of NaOH produces 1 mol of Na.

$$CoSO4 + \mathbf{2}NaOH \rightarrow Co(OH)_2 + Na_2SO_4 \quad (5)$$

$$MnSO4 + \mathbf{2}NaOH \rightarrow Mn(OH)_2 + Na_2SO_4 \quad (6)$$

$$NiSO4 + \mathbf{2}NaOH \rightarrow Ni(OH)_2 + Na_2SO_4 \quad (7)$$

1.3 Lithium Carbonate

The precipitation of lithium carbonate is done using calcium carbonate, as Eq. (8).

$$\mathbf{2}Li + Na_2CO_3 \rightarrow Li_2CO_3 + \mathbf{2}Na \quad (8)$$

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SUPPLEMENTARY MATERIAL S8 - Inventory analysis

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Inventory - Hydrometallurgical recycling in Brazil

Input				
Resouces/Materials	Amout	Unit	Assumptions	Inventory - SimaPro process
LIBs cells	1	t	1 t LIBs cells entering in treatment system	Scrap Lithium Ion battery CELLS {GLO}| scrap lithium-ion, cut-off | Cut-off, U
H2SO4 (1,5M)	0,707	t	To each 1 kg of electrolytic material entering the hydrometallurgical stage, 1.4 kg of H2SO4 is required - In the mass balance, 505.24 kg (0.50524t) enter the hydrometallurgical process, referring to the fine fraction (<0.6mm)	Sulfuric acid {RoW}| production | Cut-off, U
Glucose	0,091	t	To each 1 kg of electrolytic material entering the hydrometallurgical stage, 180g of Glucose is required (90.91kg is required for 505.24kg)	Glucose {RoW}| glucose production | Cut-off, U
Na2CO3	0,138	t	Used in the precipitation of lithium carbonate - For every 1 kg of material, 7.63 kg of Na2CO3 is required	Calcium chloride {RoW}| soda production, solvay process | Cut-off, U
NaOH	0,070	t	Used in the precipitation of ferrous slurry (43.18g/kg of material) and mixed hydroxides (431g/kg of material) - To each 1 mol of input material, 2 mols of NaOH (1:2) are required	Sodium hydroxide, without water, in 50% solution state {GLO}| market for | Cut-off, U
Water	1.167,00	L	Leaching and precipitation steps and mill washing once a week. For leaching and precipitation, 1.320L per kg of electrolytic powder is required. For washing the mills 1x/week is estimated that each mill consumes 250L per wash (25L/minute) once a week.	Tap water {BR}| market for tap water | Cut-off, U
Electricity - Crushing process	20,88	kWh	Knife mill - Electricity consumption calculed: Power value given in CV in the mill manual (20CV) - Consumption calculation performed by converting CV to W (1CV=735.5W) - Calculation (20x735.5=14.710W) - After converting W into KWh (14,710W/1000=14.71KWh) - Calculation of electricity consumption made by operating time and mill performance. Performance (700kg/h) (Average mill performance, taken from the manufacturer's website) - For 1t (14.71kWh x 1h25m (1.42h))	Electricity, medium voltage {BR-South-eastern grid}| market for electricity, medium voltage | Cut-off, U
Electricity - Shredding process	242,72	kWh	Hammer mill- Manual had feeder (0.75CV- 552W) and mill (15CV-11,032.5W) consumption - Calculation as done for the crushing process (converting CV into W and then to kWh for the operating time for the amount that enters in the mill from the previous unit operation. The feeder runs approximately 1 min (0.0166667h) for the quantity of (904.58kg) (Operating characteristics 70t/h). The mill has a capacity to grind 40kg/h - to grind 1t o mill operates 22h. The feeder and mill consumption were added together (11.0325*22h+0.552kWh*0.016h)	Electricity, medium voltage {BR-South-eastern grid}| market for electricity, medium voltage | Cut-off, U
Electricity - Sieving process	0,5016	kWh	Sieving (1.150 agitaitons/min) operating for approximately 10 minutes (5.22 W = 0.00522kWh x 0.16666h=0.88kWh). This process outputs three fractions (<0.6mm, 0.6mm>2mm, >2mm), but as the focus of the LIB recycling process is the fine fraction (<0.6mm), which is the rich content in metals, a mass allocation procedure was used to allocate energy and related impacts. (58% for the fraction <0.6mm; 26% for the fraction >2.00; 16% for the fraction 0.6mm-2mm) - Calculations performed based on the ratio of mass output from the processes. The proportions are in accordance with the literature (Pagnanelli et al., 2017) - which carried out tests to characterize the grinding/crushing of LIBs waste.	Electricity, medium voltage {BR-South-eastern grid}| market for electricity, medium voltage | Cut-off, U
Electricity - Leaching reactor	12	kWh	For the amount leached, we used capacity data from a literature reactor (Rey et al., 2021) of 0.5m3 = 500 l. For the amount leached, it is necessary to activate the reactor approximately 2 times per 3h (2kWh*3*2=12kWh)	Electricity, medium voltage {BR-South-eastern grid}| market for electricity, medium voltage | Cut-off, U

Electricity - Reactor in precipitation process	12	kWh	For precipitation, the reactor works on average 2 hours for each precipitation stage (ferrous mud, mixed hydroxides, lithium carbonate) - same leaching reactor (2kWh*2h*3 operations=12kWh)	Electricity, medium voltage {BR-South-eastern grid}| market for electricity, medium voltage | Cut-off, U
Electricity - Filtration and Evaporation	56,88	kWh	For filtration, a vacuum pump (0.18kWh) with a capacity of 2.4m3/h is used for each of the products, approximate time of 1 minute (0.003kWh) for the three filtrations). For evaporation, an oven (1.58kWh) is used for 12 hours for each product. (1.58*12*3=56.88kWh)	Electricity, medium voltage {BR-South-eastern grid}| market for electricity, medium voltage | Cut-off, U
		Output		
Air emissions	Amount	Unit	Assumptions	Inventory - SimaPro process
Electrolyte	60,66	kg	It is assumed that the mass referring to the electrolyte and solvents are evaporated in the first crushing process. There is no atmospheric emission from the electrolyte, as there is an activated carbon filter that retains the harmful gases emitted. Impacts related to carbon filter production and disposal are outside the system boundary.	-
Particulate Matter	34,11	kg	It is assumed that 50% of the total loss from crushing and shredding operations is emitted as fine particulate matter <2.5 (3.70% is the total mass loss for the fraction entering each mill) - assumed value from the literature (Costa, 2010).	Particulates, < 2.5 um
CO2	133,47	kg	Estimated by stoichiometry: 1.47kg of CO2 is emitted for each kg of glucose used in leaching.	Carbon dioxide
Steam	0,56	m3	Steam	Water/m3
Waste (solid/liquid)	Amount	Unit	Assumptions	Inventory - SimaPro process
Solid waste (paper, plastic e ferrous metals)	365,87	kg	Waste from the sieving process (medium and coarse fractions) - sent for MSW landfill.	Inert waste {RoW}| treatment of, sanitary landfill | Cut-off, U / Waste polyethylene {RoW}| treatment of waste polyethylene, sanitary landfill | Cut-off, U / Waste graphical paper {RoW}| treatment of, sanitary landfill | Cut-off, U
Mill wash residues (water + suspended solids of 50% of the total loss in each mill)	534,11	kg	It is assumed that 50% of the total loss from the crushing and shredding operations is retained on the sides of the mills (3.70% is the total loss in mass for the fraction that enters each mill) - value assumed from the literature (Costa, 2010).	Final waste flow: Sewage waste
Effluent	843,61	L	Final process effluent - hazardous. In this case, the effluent was account by mass balance and characterized by stoichiometry to account emissions to water.	Wastewater, average {CH}| treatment of, capacity 1.1E10l/year | Cut-off, U
Water emissions	Amount	Unit	Assumptions	Inventory - SimaPro process
Mn	0,0203	kg	Estimated through stoichiometric calculations and literature review (Pagnanelli et al., 2017; Aaltonen et al., 2017). Stoichiometric calculations in Supplementary Material S8.	Manganese
Co	0,0045	kg		Cobalt
Li	0,0007	kg		Lithium
Ni	0,0049	kg		Nickel
Na	64,2	kg		Sodium
SO4	136,7	kg		Sulfate
Products	Amount	Unit	Assumptions avoided product **(1:1)**	Inventory - SimaPro process
Graphite	252	kg	It is assumed that recovered graphite avoids the production of natural graphite - it does not necessarily go back to battery manufacturing as it may contain impurities - but it can be applied in other industries with lower purity requirements.	Graphite {RoW}| production | Cut-off, U
Fe2O3	10	kg	It is assumed that the recovered hematite avoids the extraction and beneficiation of iron ore.	Iron ore, beneficiated, 65% Fe {RoW}| iron ore beneficiation to 65% Fe | Cut-off, U
Mixed hydroxides: 18,7kg Mn, 112kg Co, 28,2kg Ni	159,08	kg	Mixed hydroxides are assumed to prevent the extraction and beneficiation of their respective ores. Some studies point out that this material could also be resintered with Li carbonate and return to being a precursor material for lithium ion	Nickel, 99.5% {GLO}| nickel mine operation, sulfidic ore | Cut-off, U Cobalt {GLO}| production | Cut-off, U

			batteries - however, a material adjustment step is required (which was not considered in this study).	Manganese {RoW}| production | Cut-off, U
Li2CO3	18,66	kg	The recovered material avoids the extraction and beneficiation of Li carbonate in brines.	Lithium carbonate {GLO}| production, from concentrated brine | Cut-off, U

Pyrometallurgical recycling - Europe			
Inputs	Quantity	Unit	Ecoinvent process
Waste batteries	1000	kg	used Li-ion battery
NaOH (30%)	350	kg	chlor-alkali electrolysis, mercury cell | sodium hydroxide, without water, in 50% solution state | Cutoff, S - RER
electricity, medium voltage	800	kWh	market group for electricity, medium voltage | electricity, medium voltage | Cutoff, S - RER
Water	1000	l	market group for tap water | tap water | Cutoff, S - RER
Outputs	Quantity	Unit	
Alloy	189.00	kg	treatment of used Li-ion battery, hydrometallurgical treatment - GLO - used Li-ion battery
Ferrous	40.10	kg	market for iron scrap, unsorted | iron scrap, unsorted | Cutoff, S - GLO
non-Fe-Co-metals	84.0	kg	treatment of non-Fe-Co-metals, from used Li-ion battery, pyrometallurgical processing | non-Fe-Co-metals, from used Li-ion battery, pyrometallurgical processing | Cutoff. S - GLO
Chloride	40.0	kg	Emission to water
Particulates, < 2.5 um	0,1	kg	Emission to air

Particulates, > 10 um	0.1	kg	Emission to air
Particulates, > 2.5 um, and < 10um	0.09	kg	Emission to air
Sulfate	60.0	kg	Emission to water
Sulfur dioxide	40.048	kg	Emission to air
waste plastic, mixture	0.61	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - IN
waste plastic, mixture	1.48	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - CO
waste plastic, mixture	0.19	kg	market group for waste plastic, mixture | waste plastic, mixture | Cutoff, S - RER
waste plastic, mixture	0.11	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - CY
waste plastic, mixture	0.58	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - ZA
waste plastic, mixture	22.21	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - BR
waste plastic, mixture	0.25	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - PE
waste plastic, mixture	155.5	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - RoW
Water to surface	0.15	m3	Emission to air
Water to air	0.85	m3	Emission to water

Hydrometallurgical step - Europe			
Inputs	Quantity	Unit	Ecoinvent process
Alloy	189.00	kg	used Li-ion battery
Reagent - chemical inorganic	25	kg	market for chemicals, inorganic | chemical, inorganic | Cutoff, S - GLO
Electricity	140	kWh	market group for electricity, medium voltage | electricity, medium voltage | Cutoff, S - RER
Water	0,72	m3	Water, unspecified origin
H2SO4	203.90	kg	market for sulfuric acid | sulfuric acid | Cutoff, S - RoW /
H2SO5	26.67	kg	market for sulfuric acid | sulfuric acid | Cutoff, S - RER
Lime	115.02	kg	market for lime, hydrated, packed | lime, hydrated, packed | Cutoff, S - RoW
Lime	0.98	kg	market for lime, hydrated, packed | lime, hydrated, packed | Cutoff, S - RER
Outputs products	Quantity	Unit	
Co	63,9	kg	
Ni	63,9	kg	
Output emissions	Quantity	Unit	Flow
BOD5, Biological Oxygen Demand	0,108	kg	Emission to water

Cobalt	0,000017	kg	Emission to water
COD, Chemical Oxygen Demand	0,03	kg	Emission to water
Copper, ion	0,0000165	kg	Emission to water
DOC, Dissolved Organic Carbon	0,0111	kg	Emission to water
Fluoride	0,00003	kg	Emission to water
Hydrocarbons, unspecified	0,00001	kg	Emission to water
inert waste, for final disposal	200,69	kg	market for inert waste, for final disposal | inert waste, for final disposal | Cutoff, S - RoW
inert waste, for final disposal	1,31	kg	market for inert waste, for final disposal | inert waste, for final disposal | Cutoff, S - CH
Nickel, ion	0,0000165	kg	Emission to water
NMVOC, non-methane volatile organic compounds, unspecified origin	0,0025	kg	Emission to air
Sulfur dioxide	0,0045	kg	Emission to air
Suspended solids, unspecified	0,012	kg	Emission to water
TOC, Total Organic Carbon	0,0111	kg	Emission to water
waste graphical paper	0,038	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - CY
waste graphical paper	2,84	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - BR

waste graphical paper	6,97	kg	market group for waste graphical paper | waste graphical paper | Cutoff, S - RER
waste graphical paper	52,73	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - RoW
waste graphical paper	0,16	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - PE
waste graphical paper	1,57	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - IN
waste graphical paper	0,29	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - ZA
waste graphical paper	0,44	kg	market for waste graphical paper | waste graphical paper | Cutoff, S - CO
waste gypsum	78,78	kg	market for waste gypsum | waste gypsum | Cutoff, S - Europe without Switzerland
waste gypsum	256,5	kg	market for waste gypsum | waste gypsum | Cutoff, S - RoW
waste plastic, mixture	0,08	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - PE
waste plastic, mixture	0,1892	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - ZA
waste plastic, mixture	6,25	kg	market group for waste plastic, mixture | waste plastic, mixture | Cutoff, S - RER
waste plastic, mixture	0,036	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - CY
waste plastic, mixture	0,49	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - CO
waste plastic, mixture	50,53	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - RoW
waste plastic, mixture	0,19	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - IN

waste plastic, mixture	7,26	kg	market for waste plastic, mixture | waste plastic, mixture | Cutoff, S - BR
Water	0,612	m3	Emission to water
Water	0,108	m3	Emission to air

SUPPLEMENTARY MATERIAL 9 – Numerical results of contribution analysis for hydrometallurgical recycling - Brazil

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Table 1. Results of hydrometallurgical recycling in Brazil.

Impact category	Unity	Crushing	Shredding	Sieving	Hydrometallurgy	Total
Climate change	kg CO2 eq	6,00E+00	6,86E+01	1,34E+02	3,02E+02	5,10E+02
Ozone depletion	kg CFC-11 eq	3,91E-07	4,45E-06	3,43E-07	6,87E-05	7,39E-05
Human Toxicity - non cancer	CTUh	7,81E-07	8,48E-06	1,06E-04	-6,31E-05	5,25E-05
Human Toxicity - cancer effects	CTUh	5,80E-08	4,69E-07	9,24E-07	1,13E-05	1,27E-05
Particulate matter	kg PM2.5 eq	1,74E+01	1,68E+01	2,97E-03	6,86E-01	3,49E+01
Ionizing radiation HH	kBq U235 eq	9,14E-01	1,05E+01	3,63E-01	2,52E+01	3,69E+01
Ionizing radiation E (interim)	CTUe	2,40E-06	2,76E-05	1,50E-06	9,01E-05	1,22E-04
Photochemical ozone formation	kg NMVOC eq	9,15E-03	1,03E-01	6,89E-02	1,70E+00	1,88E+00
Acidification	molc H+ eq	2,16E-02	2,39E-01	3,16E-02	1,07E+01	1,10E+01
Terrestrial eutrophication	molc N eq	4,06E-02	4,60E-01	1,04E-01	1,10E+01	1,16E+01
Freshwater eutrophication	kg P eq	3,54E-04	3,58E-03	1,08E-03	1,04E-01	1,09E-01
Marine eutrophication	kg N eq	3,84E-03	4,35E-02	2,69E-01	8,69E-01	1,18E+00
Freshwater ecotoxicity	CTUe	9,21E+00	6,44E+01	9,39E+03	1,75E+03	1,12E+04
Land Use	kg C deficit	8,30E-01	8,32E+00	8,11E+00	6,91E+02	7,08E+02
Water resource depletion	m3 water eq	-1,62E-03	4,89E-03	-7,92E-04	3,42E+00	3,43E+00
Mineral, fossil & ren resource depletion	kg Sb eq	2,07E-05	1,17E-04	3,66E-06	1,96E-02	1,98E-02

SUPPLEMENTARY MATERIAL 10 – Numerical contribution analysis - Pyrohydrometallurgical recycling in Europe

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Figure 1. Contribution analysis - Pyrohydrometallurgical recycling in Europe

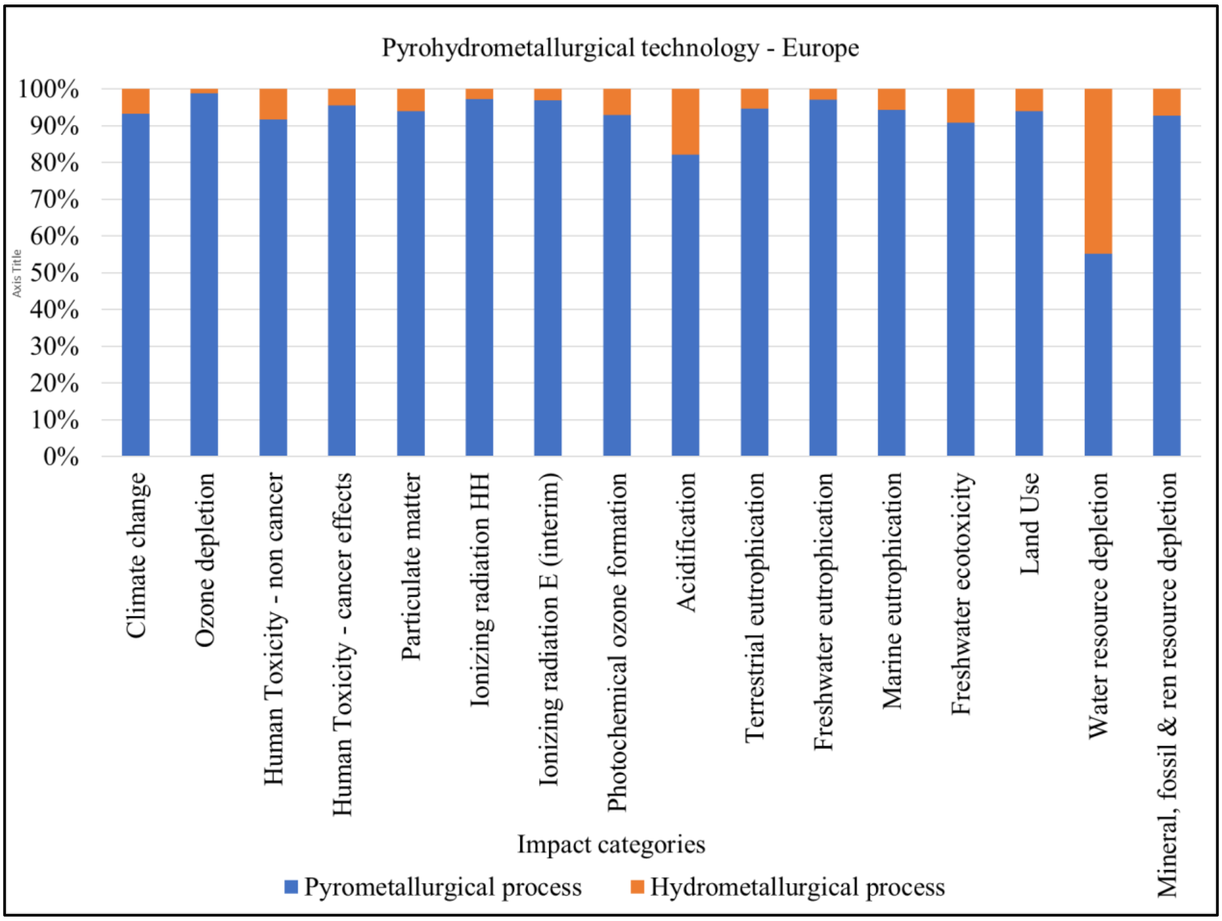

Table 1. Overall results of pyrohydrometallurgical recycling in Europe.

Impact category	Unity	Direct impact	Sodium hydroxide	Electricity	Non-Fe-Co-metals	Waste plastics	Hydrometallurgical	Total
Climate change	kg CO2 eq	0,00E+00	4,16E+02	5,59E+02	6,37E+01	1,19E+02	8,24E+01	1,24E+03
Ozone depletion	kg CFC-11 eq	0,00E+00	2,79E-04	2,44E-05	2,75E-06	3,30E-07	3,52E-06	3,10E-04
Human Toxicity - non cancer	CTUh	0,00E+00	9,40E-05	1,07E-04	1,23E-05	1,69E-04	3,43E-05	4,17E-04
Human Toxicity - cancer effects	CTUh	0,00E+00	2,00E-05	2,76E-05	8,75E-06	4,18E-06	2,87E-06	6,34E-05
Particulate matter	kg PM2.5 eq	3,50E-01	3,73E-01	5,09E-01	6,12E-02	6,61E-01	1,26E-01	2,08E+00
Ionizing radiation HH	kBq U235 eq	0,00E+00	5,72E+01	8,39E+01	9,44E+00	2,70E-01	4,19E+00	1,55E+02
Ionizing radiation E (interim)	CTUe	0,00E+00	1,93E-03	2,77E-04	3,11E-05	-1,74E-03	1,61E-05	5,18E-04
Photochemica l ozone formation	kg NMVOC eq	3,89E-03	1,21E+00	1,39E+00	1,89E-01	2,06E-01	2,31E-01	3,23E+00
Acidification	molc H+ eq	6,29E-02	2,25E+00	2,80E+00	3,72E-01	1,35E-01	1,22E+00	6,84E+00
Terrestrial eutrophicatio n	molc N eq	0,00E+00	4,69E+00	5,23E+00	7,16E-01	7,25E-01	6,39E-01	1,20E+01
Freshwater eutrophicatio n	kg P eq	0,00E+00	1,97E-01	2,81E-01	3,19E-02	8,00E-04	1,53E-02	5,26E-01

Marine eutrophication	kg N eq	0,00E+00	4,80E-01	5,28E-01	7,10E-02	3,64E-01	8,67E-02	1,53E+00
Freshwater ecotoxicity	CTUe	0,00E+00	1,86E+03	2,52E-03	2,88E+02	1,15E+04	1,37E+03	1,50E+04
Land Use	kg C deficit	0,00E+00	9,56E+01	1,16E+02	1,37E+01	6,60E+00	1,51E+01	2,47E+02
Water resource depletion	m3 water eq	2,43E-02	9,66E-01	-7,83E-01	-7,44E-02	4,01E-02	1,40E-01	3,13E-01
Mineral, fossil & ren resource depletion	kg Sb eq	0,00E+00	4,98E-03	8,49E-04	9,58E-05	1,94E-01	1,56E-02	2,16E-01

Table 2. Results of hydrometallurgical step in pyrohydrometallurgical recycling in Europe.

Impact category	Unity	Direct impact	Chemical inorganic	Lime	Sulfuric acid	Electricity	Inert waste	Waste gypsum	Waste graphical / plastics	Total
Climate change	kg CO2 eq	0,00E+00	8,72E+00	2,05E+01	3,96E+00	1,84E+01	1,85E-01	1,67E-01	3,05E+01	8,24E+01
Ozone depletion	kg CFC-11 eq	0,00E+00	1,00E-06	1,19E-06	4,77E-07	8,02E-07	3,15E-08	1,89E-08	2,99E-09	3,52E-06
Human Toxicity - non cancer	CTUh	9,35E-12	2,29E-06	6,20E-07	1,33E-05	3,53E-06	1,67E-08	7,83E-07	1,38E-05	3,43E-05
Human Toxicity - cancer effects	CTUh	1,19E-10	1,02E-06	5,61E-08	4,77E-07	9,08E-07	8,26E-10	2,30E-08	3,85E-07	2,87E-06
Particulate matter	kg PM2.5 eq	5,64E-05	7,59E-03	2,64E-03	1,97E-02	1,67E-02	1,62E-04	1,59E-02	6,33E-02	1,26E-01
Ionizing radiation HH	kBq U235 eq	0,00E+00	5,32E-01	4,85E-01	3,53E-01	2,76E+00	1,16E-02	1,51E-02	3,35E-02	4,19E+00
Ionizing radiation E (interim)	CTUe	0,00E+00	2,04E-06	2,32E-06	1,71E-06	9,11E-06	7,84E-08	6,50E-08	7,77E-07	1,61E-05
Photochemical ozone formation	kg NMVOC eq	5,39E-04	2,48E-02	2,30E-02	6,50E-02	4,58E-02	1,92E-03	2,22E-02	4,77E-02	2,31E-01
Acidification	molc H+ eq	1,11E-03	6,87E-02	3,30E-02	3,88E-01	9,20E-02	1,56E-03	3,41E-01	2,95E-01	1,22E+00
Terrestrial eutrophication	molc N eq	0,00E+00	1,21E-01	8,06E-02	1,67E-01	1,72E-01	7,23E-03	4,27E-03	8,70E-02	6,39E-01
Freshwater eutrophication	kg P eq	0,00E+00	2,74E-03	4,96E-04	2,56E-03	9,25E-03	7,35E-06	2,33E-05	2,23E-04	1,53E-02

Marine eutrophication	kg N eq	0,00E+00	8,84E-03	7,42E-03	1,52E-02	1,74E-02	6,59E-04	3,92E-04	3,68E-02	8,67E-02
Freshwater ecotoxicity	CTUe	2,31E-01	8,44E+01	1,21E+01	5,25E+02	8,29E+01	3,63E-01	1,13E+01	6,53E+02	1,37E+03
Land Use	kg C deficit	0,00E+00	5,15E+00	2,96E+00	1,70E+00	3,82E+00	1,15E-01	2,54E-01	1,10E+00	1,51E+01
Water resource depletion	m3 water eq	3,29E-03	1,84E-02	3,55E-03	1,38E-01	-2,58E-02	5,33E-05	2,66E-04	2,34E-03	1,40E-01
Mineral, fossil & ren resource depletion	kg Sb eq	0,00E+00	3,29E-03	5,52E-06	1,23E-02	2,79E-05	1,76E-07	1,28E-07	4,45E-05	1,56E-02

Table 3. Results of transport for Europe.

Impact category	Unity	Transport
Climate change	kg CO2 eq	91,8
Ozone depletion	kg CFC-11 eq	0,00001575
Human Toxicity - non cancer	CTUh	0,00000562
Human Toxicity - cancer effects	CTUh	0,000000177
Particulate matter	kg PM2.5 eq	0,0751
Ionizing radiation HH	kBq U235 eq	5,4
Ionizing radiation E (interim)	CTUe	0,0000379

Photochemical ozone formation	kg NMVOC eq	1,293
Acidification	molc H+ eq	1,92
Terrestrial eutrophication	molc N eq	5,044
Freshwater eutrophication	kg P eq	0,001041
Marine eutrophication	kg N eq	0,4537
Freshwater ecotoxicity	CTUe	109
Land Use	kg C deficit	1,275
Water resource depletion	m3 water eq	0,01465
Mineral, fossil & ren resource depletion	kg Sb eq	0,0000454

SUPPLEMENTARY MATERIAL 11 – Avoided impacts

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Figure 1. Contribution analysis of avoided impact of hydrometallurgical recycling Brazil.

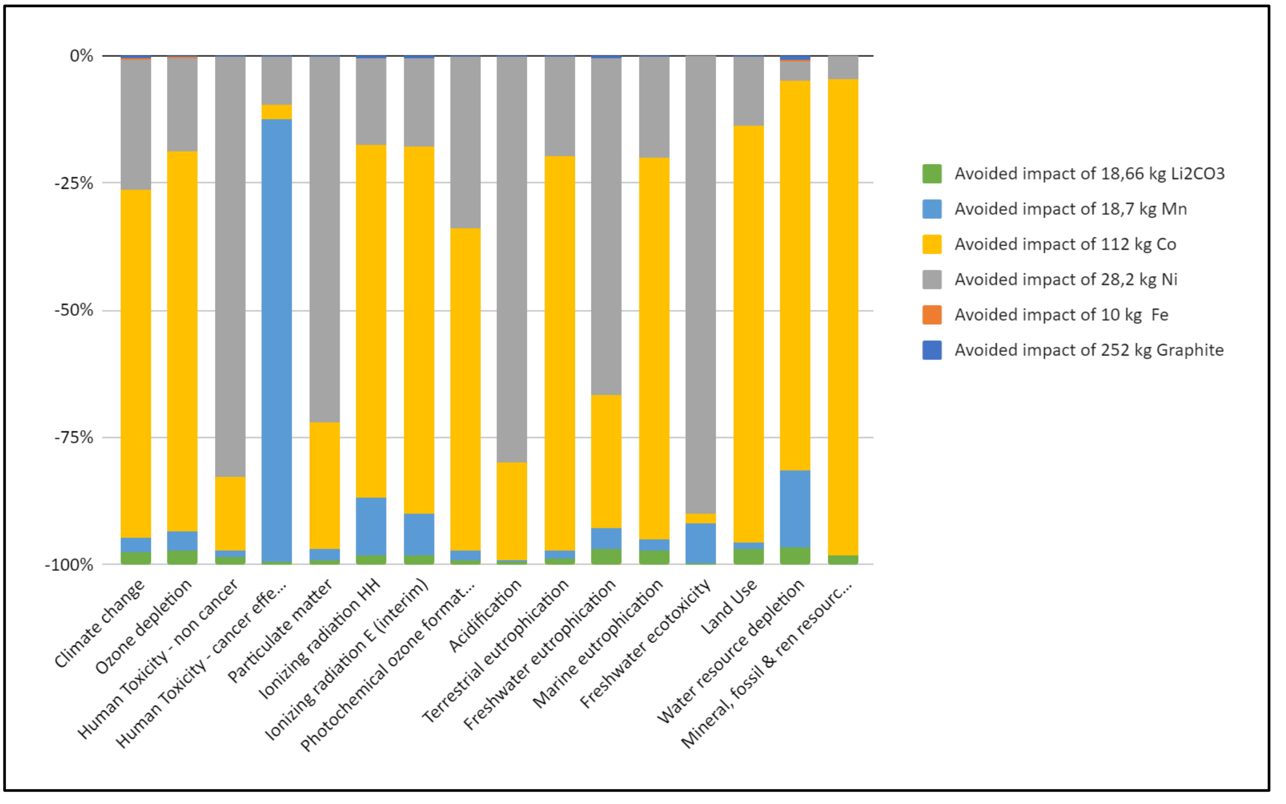

Table 1. Results of avoided impact of hydrometallurgical recycling Brazil.

Impact category	Unity	Avoided impact of 252 kg Graphite	Avoided impact of 10 kg Fe	Avoided impact of 28,2 kg Ni	Avoided impact of 112 kg Co	Avoided impact of 18,7 kg Mn	Avoided impact of 18,66 kg Li2CO3	Total avoided impacts
Climate change	kg CO2 eq	-9,53E+00	-2,16E-01	-3,72E+02	-9,86E+02	-4,41E+01	-3,40E+01	-1,45E+03
Ozone depletion	kg CFC-11 eq	-3,25E-07	-2,41E-08	-1,83E-05	-7,43E-05	-3,96E-06	-2,65E-06	-9,95E-05
Human Toxicity - non cancer	CTUh	-1,74E-06	-6,63E-08	-1,11E-03	-1,96E-04	-1,80E-05	-1,88E-05	-1,34E-03
Human Toxicity - cancer effects	CTUh	-3,73E-07	-1,49E-08	-1,07E-04	-3,35E-05	-9,82E-04	-7,24E-06	-1,13E-03

Particulate matter	kg PM2.5 eq	-1,18E-02	-1,06E-03	-2,93E+00	-1,01E+00	-9,56E-02	-3,58E-02	-4,08E+00
Ionizing radiation HH	kBq U235 eq	-6,70E-01	-4,01E-02	-2,18E+01	-8,86E+01	-1,47E+01	-2,22E+00	-1,28E+02
Ionizing radiation E (interim)	CTUe	-2,62E-06	-1,51E-07	-8,54E-05	-3,55E-04	-4,08E-05	-9,35E-06	-4,93E-04
Photochemical ozone formation	kg NMVOC eq	-3,70E-02	-3,12E-03	-6,09E+00	-1,14E+01	-3,25E-01	-1,52E-01	-1,80E+01
Acidification	molc H+ eq	-6,65E-02	-3,39E-03	-5,47E+01	-1,31E+01	-3,76E-01	-3,17E-01	-6,86E+01
Terrestrial eutrophication	molc N eq	-1,51E-01	-1,52E-02	-1,43E+01	-5,71E+01	-1,19E+00	-9,40E-01	-7,37E+01
Freshwater eutrophication	kg P eq	-3,60E-03	-8,85E-05	-6,77E-01	-2,68E-01	-3,96E-02	-3,25E-02	-1,02E+00
Marine eutrophication	kg N eq	-1,31E-02	-1,10E-03	-1,03E+00	-3,95E+00	-1,10E-01	-1,47E-01	-5,25E+00
Freshwater ecotoxicity	CTUe	-3,68E+01	-1,71E+00	-1,57E+05	-3,77E+03	-1,37E+04	-2,37E+02	-1,74E+05
Land Use	kg C deficit	-2,92E+00	-9,62E-02	-8,32E+02	-4,93E+03	-6,30E+01	-1,92E+02	-6,02E+03
Water resource depletion	m3 water eq	-1,41E-02	-5,08E-04	-6,06E-02	-1,14E+00	-2,21E-01	-5,30E-02	-1,49E+00
Mineral, fossil & ren resource depletion	kg Sb eq	-8,52E-06	-1,32E-05	-1,90E-01	-3,81E+00	-1,77E-03	-7,20E-02	-4,07E+00

Figure 2. Contribution analysis of avoided impact of Pyrohydrometallurgical recycling Europe.

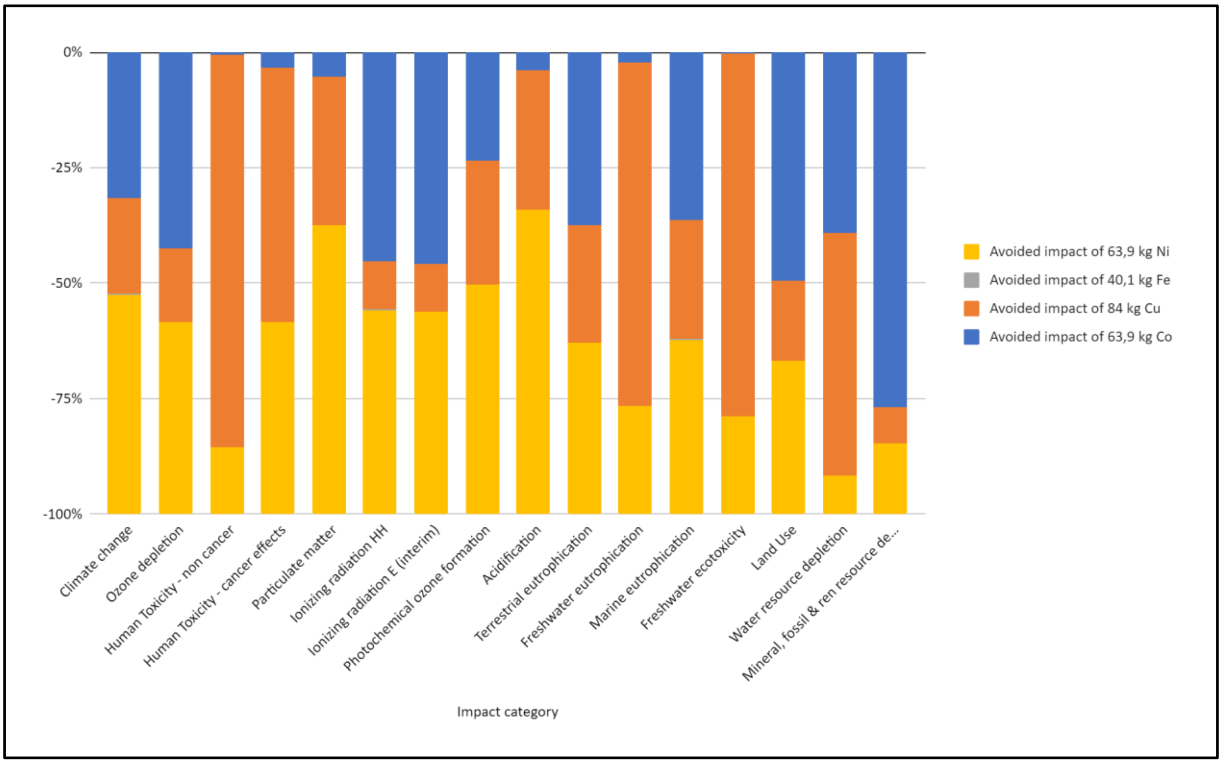

Table 2. Results of avoided impact of Pyrohydrometallurgical recycling Europe.

Impact category	Unity	Avoided impact of 63,9 kg Co	Avoided impact of 84 kg Cu	Avoided impact of 40,1 kg Fe	Avoided impact of 63,9 kg Ni	Total avoided impact
Climate change	kg CO2 eq	-5,62E+02	-3,67E+02	-8,64E-01	-8,44E+02	-1,77E+03
Ozone depletion	kg CFC-11 eq	-4,24E-05	-1,59E-05	-9,67E-08	-4,14E-05	-9,98E-05
Human Toxicity - non cancer	CTUh	-1,12E-04	-1,47E-02	-2,66E-07	-2,51E-03	-1,73E-02
Human Toxicity - cancer effects	CTUh	-1,91E-05	-3,24E-04	-5,98E-08	-2,43E-04	-5,86E-04
Particulate matter	kg PM2.5 eq	-5,74E-01	-3,39E+00	-4,27E-03	-6,64E+00	-1,06E+01
Ionizing radiation HH	kBq U235 eq	-5,05E+01	-1,18E+01	-1,61E-01	-4,94E+01	-1,12E+02
Ionizing radiation E (interim)	CTUe	-2,03E-04	-4,55E-05	-6,05E-07	-1,94E-04	-4,43E-04
Photochemical ozone	kg NMVOC eq	-6,50E+00	-7,42E+00	-1,25E-02	-1,38E+01	-2,77E+01

formation						
Acidification	molc H+ eq	-7,51E+00	-5,65E+01	-1,36E-02	-1,24E+02	-1,88E+02
Terrestrial eutrophication	molc N eq	-3,26E+01	-2,23E+01	-6,10E-02	-3,23E+01	-8,73E+01
Freshwater eutrophication	kg P eq	-1,52E-01	-4,84E+00	-3,55E-04	-1,53E+00	-6,52E+00
Marine eutrophication	kg N eq	-2,25E+00	-1,59E+00	-4,39E-03	-2,33E+00	-6,17E+00
Freshwater ecotoxicity	CTUe	-2,15E+03	-1,31E+06	-6,84E+00	-3,55E+05	-1,67E+06
Land Use	kg C deficit	-2,81E+03	-9,75E+02	-3,86E-01	-1,89E+03	-5,68E+03
Water resource depletion	m3 water eq	-6,53E-01	-8,74E-01	-2,04E-03	-1,37E-01	-1,67E+00
Mineral, fossil & ren resource depletion	kg Sb eq	-2,17E+00	-2,17E-01	-5,28E-05	-4,31E-01	-2,82E+00

SUPPLEMENTARY MATERIAL 12 - Numerical results of scenarios assessment

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Scenario 1 (2023)								
Impact category	Unity	External recycling (90 t)	Intermediary transport (18000 tkm)	Sea transport (842.490 tkm)	Landfill (2.925 t)	Total of impacts	Avoided impact of external recycling	Net impact scenario 1
Climate change	kg CO2 eq	1,12E+05	3,19E+03	5,07E+03	2,04E+06	2,16E+06	-1,60E+05	2,00E+06
Ozone depletion	kg CFC-11 eq	3,00E-02	0,00E+00	0,00E+00	0,00E+00	3,00E-02	-1,00E-02	2,00E-02
Human Toxicity - non cancer	CTUh	4,00E-02	0,00E+00	0,00E+00	4,41E+00	4,45E+00	-1,56E+00	2,89E+00
Human Toxicity - cancer effects	CTUh	1,00E-02	0,00E+00	0,00E+00	7,00E-02	7,00E-02	-5,00E-02	2,00E-02
Particulate matter	kg PM2.5 eq	1,87E+02	9,80E-01	5,78E+00	4,59E+01	2,40E+02	-9,55E+02	-7,15E+02
Ionizing radiation HH	kBq U235 eq	1,39E+04	1,96E+02	2,90E+02	4,01E+03	1,84E+04	-1,01E+04	8,33E+03
Ionizing radiation E (interim)	CTUe	5,00E-02	0,00E+00	0,00E+00	2,00E-02	7,00E-02	-4,00E-02	3,00E-02
Photochemical ozone formation	kg NMVOC eq	2,91E+02	1,46E+01	1,02E+02	9,16E+02	1,32E+03	-2,50E+03	-1,17E+03
Acidification	molc H+ eq	6,15E+02	1,44E+01	1,58E+02	3,99E+02	1,19E+03	-1,69E+04	-1,57E+04
Terrestrial eutrophication	molc N eq	1,08E+03	5,71E+01	3,97E+02	1,09E+03	2,62E+03	-7,85E+03	-5,23E+03
Freshwater eutrophication	kg P eq	4,73E+01	6,00E-02	3,00E-02	4,44E+01	9,18E+01	-5,87E+02	-4,95E+02
Marine eutrophication	kg N eq	1,38E+02	5,19E+00	3,56E+01	5,20E+03	5,38E+03	-5,56E+02	4,82E+03
Freshwater ecotoxicity	CTUe	1,35E+06	8,62E+03	1,19E+03	3,28E+08	3,29E+08	-1,50E+08	1,79E+08
Land Use	kg C deficit	2,22E+04	8,17E+01	3,31E+01	6,78E+04	9,01E+04	-5,11E+05	-4,21E+05
Water resource depletion	m3 water eq	2,81E+01	1,02E+00	3,00E-01	-2,31E+01	6,32E+00	-1,50E+02	-1,44E+02
Mineral, fossil & ren resource depletion	kg Sb eq	1,94E+00	0,00E+00	0,00E+00	6,00E-02	2,00E+00	-2,54E+02	-2,52E+02

Scenario 2 (2024)										
Impact category	Unity	External recycling (282 t)	Brazil recycling (47,1 t)	Intermediary transport (56.400 tkm)	Sea transport (2.639.7 tkm)	Landfill (2.809 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact scenario 2
Climate change	kg CO2 eq	3,51E+05	2,40E+04	1,00E+04	1,59E+04	1,96E+06	2,36E+06	-5,00E+05	-6,81E+04	1,79E+06
Ozone depletion	kg CFC-11 eq	9,00E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,00E-01	-3,00E-02	0,00E+00	7,00E-02
Human Toxicity - non cancer	CTUh	1,20E-01	0,00E+00	0,00E+00	0,00E+00	4,23E+00	4,35E+00	-4,88E+00	-6,00E-02	-6,00E-01
Human Toxicity - cancer effects	CTUh	2,00E-02	0,00E+00	0,00E+00	0,00E+00	6,00E-02	8,00E-02	-1,70E-01	-5,00E-02	-1,40E-01
Particulate matter	kg PM2.5 eq	5,87E+02	1,64E+03	3,07E+00	1,81E+01	4,40E+01	2,29E+03	-2,99E+03	-1,92E+02	-8,90E+02
Ionizing radiation HH	kBq U235 eq	4,37E+04	1,74E+03	6,15E+02	9,09E+02	3,85E+03	5,08E+04	-3,15E+04	-6,03E+03	1,32E+04
Ionizing radiation E (interim)	CTUe	1,50E-01	1,00E-02	0,00E+00	1,00E-02	2,00E-02	1,80E-01	-1,20E-01	-2,00E-02	3,00E-02
Photochemical ozone formation	kg NMVOC eq	9,11E+02	8,85E+01	4,59E+01	3,19E+02	8,80E+02	2,24E+03	-7,82E+03	-8,49E+02	-6,43E+03
Acidification	molc H+ eq	1,93E+03	5,16E+02	4,51E+01	4,96E+02	3,83E+02	3,37E+03	-5,30E+04	-3,23E+03	-5,29E+04
Terrestrial eutrophication	molc N eq	3,40E+03	5,47E+02	1,79E+02	1,24E+03	1,04E+03	6,41E+03	-2,46E+04	-3,47E+03	-2,17E+04
Freshwater eutrophication	kg P eq	1,48E+02	5,14E+00	2,00E-01	1,00E-01	4,26E+01	1,96E+02	-1,84E+03	-4,81E+01	-1,69E+03
Marine eutrophication	kg N eq	4,32E+02	5,58E+01	1,63E+01	1,12E+02	4,99E+03	5,61E+03	-1,74E+03	-2,47E+02	3,62E+03
Freshwater ecotoxicity	CTUe	4,23E+06	5,28E+05	2,70E+04	3,71E+03	3,15E+08	3,20E+08	-4,70E+08	-8,21E+06	-1,59E+08
Land Use	kg C deficit	6,97E+04	3,34E+04	2,56E+02	1,04E+02	6,51E+04	1,69E+05	-1,60E+06	-2,83E+05	-1,72E+06
Water resource depletion	m3 water eq	8,81E+01	1,61E+02	3,18E+00	9,50E-01	-2,22E+01	2,31E+02	-4,70E+02	-7,02E+01	-3,09E+02
Mineral, fossil & ren resource depletion	kg Sb eq	6,08E+00	9,30E-01	1,00E-02	0,00E+00	5,00E-02	7,08E+00	-7,95E+02	-1,92E+02	-9,79E+02

Scenario 3 (2025)										
Impact category	Unity	External recycling (271 t)	Brazil recycling (135,7 t)	Intermediary transport(54.200 tkm)	Sea transport (2.536.8 tkm)	Landfill (2.786 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact Scenario 3
Climate change	kg CO2 eq	3,37E+05	6,92E+04	9,61E+03	1,53E+04	1,94E+06	2,37E+06	-4,81E+05	-1,96E+05	1,69E+06
Ozone depletion	kg CFC-11 eq	8,00E-02	1,00E-02	0E+00	0,00E+00	0,00E+00	1,00E-01	-3,00E-02	-1,00E-02	6,00E-02
Human Toxicity - non cancer	CTUh	1,10E-01	1,00E-02	0,00E+00	0,00E+00	4,20E+00	4,32E+00	-4,69E+00	-1,80E-01	-5,50E-01
Human Toxicity - cancer effects	CTUh	2,00E-02	0,00E+00	0,00E+00	0,00E+00	6,00E-02	8,00E-02	-1,60E-01	-1,50E-01	-2,30E-01
Particulate matter	kg PM2.5 eq	5,64E+02	4,73E+03	2,95E+00	1,74E+01	4,37E+01	5,36E+03	-2,87E+03	-5,54E+02	1,93E+03
Ionizing radiation HH	kBq U235 eq	4,20E+04	5,01E+03	5,91E+02	8,74E+02	3,82E+03	5,23E+04	-3,03E+04	-1,74E+04	4,61E+03
Ionizing radiation E (interim)	CTUe	1,40E-01	2,00E-02	0,00E+00	1,00E-02	2,00E-02	1,80E-01	-1,20E-01	-7,00E-02	-1,00E-02
Photochemical ozone formation	kg NMVOC eq	8,76E+02	2,55E+02	4,41E+01	3,06E+02	8,72E+02	2,35E+03	-7,52E+03	-2,45E+03	-7,61E+03
Acidification	molc H+ eq	1,85E+03	1,49E+03	4,34E+01	4,76E+02	3,80E+02	4,24E+03	-5,10E+04	-9,31E+03	-5,60E+04
Terrestrial eutrophication	molc N eq	3,26E+03	1,58E+03	1,72E+02	1,20E+03	1,04E+03	7,25E+03	-2,36E+04	-1,00E+04	-2,64E+04
Freshwater eutrophication	kg P eq	1,42E+02	1,48E+01	1,90E-01	9,00E-02	4,23E+01	1,99E+02	-1,77E+03	-1,38E+02	-1,71E+03
Marine eutrophication	kg N eq	4,15E+02	1,61E+02	1,56E+01	1,07E+02	4,95E+03	5,65E+03	-1,67E+03	-7,13E+02	3,26E+03
Freshwater ecotoxicity	CTUe	4,07E+06	1,52E+06	2,60E+04	3,57E+03	3,12E+08	3,18E+08	-4,52E+08	-2,36E+07	-1,58E+08
Land Use	kg C deficit	6,69E+04	9,61E+04	2,46E+02	9,96E+01	6,46E+04	2,28E+05	-1,54E+06	-8,17E+05	-2,13E+06
Water resource depletion	m3 water eq	8,47E+01	4,65E+02	3,06E+00	9,10E-01	-2,20E+01	5,32E+02	-4,52E+02	-2,02E+02	-1,22E+02
Mineral, fossil & ren resource depletion	kg Sb eq	5,85E+00	2,68E+00	1,00E-02	0,00E+00	5,00E-02	8,60E+00	-7,64E+02	-5,53E+02	-1,31E+03

Scenario 4 (2026)										
Impact category	Unity	External recycling (411 t)	Brazil recycling (1.232,4 t)	Intermediary transport(82.200 tkm)	Sea transport (3.847.3 tkm)	Landfill (1.643 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact Scenario 4
Climate change	kg CO2 eq	5,11E+05	6,29E+05	1,46E+04	2,31E+04	1,15E+06	2,33E+06	-7,29E+05	-1,78E+06	-1,83E+05
Ozone depletion	kg CFC-11 eq	1,28E-01	9,10E-02	2,62E-03	3,86E-03	1,79E-03	2,27E-01	-4,10E-02	-1,23E-01	6,37E-02
Human Toxicity - non cancer	CTUh	1,71E-01	6,47E-02	1,80E-03	5,06E-04	2,47E+00	2,71E+00	-7,12E+00	-1,65E+00	-6,06E+00
Human Toxicity - cancer effects	CTUh	2,61E-02	1,57E-02	4,48E-05	2,79E-05	3,66E-02	7,85E-02	-2,41E-01	-1,39E+00	-1,56E+00
Particulate matter	kg PM2.5 eq	8,56E+02	4,30E+04	4,47E+00	2,64E+01	2,58E+01	4,39E+04	-4,36E+03	-5,03E+03	3,45E+04
Ionizing radiation HH	kBq U235 eq	6,37E+04	4,55E+04	8,97E+02	1,33E+03	2,25E+03	1,14E+05	-4,60E+04	-1,58E+05	-9,01E+04
Ionizing radiation E (interim)	CTUe	2,13E-01	1,50E-01	6,28E-03	9,28E-03	8,95E-03	3,87E-01	-1,82E-01	-6,08E-01	-4,03E-01
Photochemical ozone formation	kg NMVOC eq	1,33E+03	2,32E+03	6,69E+01	4,64E+02	5,15E+02	4,69E+03	-1,14E+04	-2,22E+04	-2,89E+04
Acidification	molc H+ eq	2,81E+03	1,35E+04	6,58E+01	7,22E+02	2,24E+02	1,73E+04	-7,73E+04	-8,45E+04	-1,44E+05
Terrestrial eutrophication	molc N eq	4,95E+03	1,43E+04	2,61E+02	1,81E+03	6,10E+02	2,19E+04	-3,59E+04	-9,08E+04	-1,05E+05
Freshwater eutrophication	kg P eq	2,16E+02	1,34E+02	2,87E-01	1,41E-01	2,49E+01	3,76E+02	-2,68E+03	-1,26E+03	-3,56E+03
Marine eutrophication	kg N eq	6,29E+02	1,46E+03	2,37E+01	1,63E+02	2,92E+03	5,20E+03	-2,54E+03	-6,47E+03	-3,81E+03
Freshwater ecotoxicity	CTUe	6,17E+06	1,38E+07	3,94E+04	5,41E+03	1,84E+08	2,04E+08	-6,85E+08	-2,15E+08	-6,96E+08
Land Use	kg C deficit	1,02E+05	8,73E+05	3,73E+02	1,51E+02	3,81E+04	1,01E+06	-2,33E+06	-7,42E+06	-8,74E+06
Water resource depletion	m3 water eq	1,28E+02	4,22E+03	4,64E+00	1,38E+00	-1,30E+01	4,34E+03	-6,85E+02	-1,84E+03	1,82E+03
Mineral, fossil & ren resource depletion	kg Sb eq	8,87E+00	2,43E+01	1,40E-02	4,63E-03	3,16E-02	3,33E+01	-1,16E+03	-5,02E+03	-6,14E+03

SUPPLEMENTARY MATERIAL 13 - Results of sensitivity analysis

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Parameters	H2SO4 (kg)	Glucose (kg)	Na2CO3 (kg)	NaOH (kg)	Water (L)	Electricity - Leach and precipitation (kWh		
Original value	707,00	91,00	138,00	70,00	667,00	12,00	12,00	56,88
(-)5%	671,65	86,45	131,10	66,50	633,65	11,40	11,40	54,04
(+)5%	742,35	95,55	144,90	73,50	700,35	12,60	12,60	59,72
(-)10%	636,30	81,90	124,20	63,00	600,30	10,80	10,80	51,19
(+)10%	777,70	100,10	151,80	77,00	733,70	13,20	13,20	62,57

Global sensitivity analysis _Hydrometallurgy

Absolute value

Impact category	Unidade	(-)5%	(-)10%	Original value	(+)5%	(+)10%
Climate change	kg CO2 eq	2,88E+02	2,72E+02	3,02E+02	3,16E+02	3,33E+02
Ozone depletion	kg CFC-11 eq	6,52E-05	6,18E-05	6,87E-05	7,21E-05	7,55E-05
Human Toxicity - non cancer	CTUh	-5,96E-05	-5,64E-05	-6,31E-05	-6,61E-05	-6,93E-05
Human Toxicity - cancer effects	CTUh	1,08E-05	1,02E-05	1,13E-05	1,19E-05	1,24E-05
Particulate matter	kg PM2.5 eq	6,52E-01	6,18E-01	6,86E-01	7,21E-01	7,55E-01
Ionizing radiation HH	kBq U235 eq	2,40E+01	2,27E+01	2,52E+01	2,65E+01	2,77E+01
Ionizing radiation E (interim)	CTUe	8,56E-05	8,11E-05	9,01E-05	9,46E-05	9,91E-05
Photochemical ozone formation	kg NMVOC eq	1,61E+00	1,53E+00	1,70E+00	1,78E+00	1,87E+00
Acidification	molc H+ eq	1,01E+01	9,60E+00	1,07E+01	1,12E+01	1,17E+01
Terrestrial eutrophication	molc N eq	1,05E+01	9,92E+00	1,10E+01	1,16E+01	1,21E+01
Freshwater eutrophication	kg P eq	9,90E-02	9,38E-02	1,04E-01	1,09E-01	1,14E-01
Marine eutrophication	kg N eq	8,27E-01	7,84E-01	8,69E-01	9,12E-01	9,54E-01
Freshwater ecotoxicity	CTUe	1,67E+03	1,59E+03	1,75E+03	1,84E+03	1,92E+03
Land Use	kg C deficit	6,57E+02	6,22E+02	6,91E+02	7,26E+02	7,60E+02
Water resource depletion	m3 water eq	3,25E+00	3,08E+00	3,42E+00	3,60E+00	3,77E+00
Mineral, fossil & ren resource depletion	kg Sb eq	1,87E-02	1,77E-02	1,96E-02	2,07E-02	2,17E-02

% of variation

Impact category	Unidade	(-)5%	(-)10%	Original value	(+)5%	(+)10%
Climate change	kg CO2 eq	-4,64%	-9,93%	3,02E+02	4,64%	10,26%
Ozone depletion	kg CFC-11 eq	-5,09%	-10,04%	6,87E-05	4,95%	9,90%
Human Toxicity - non cancer	CTUh	-5,55%	-10,62%	-6,31E-05	4,75%	9,83%
Human Toxicity - cancer effects	CTUh	-4,42%	-9,73%	1,13E-05	5,31%	9,73%
Particulate matter	kg PM2.5 eq	-4,96%	-9,91%	6,86E-01	5,10%	10,06%
Ionizing radiation HH	kBq U235 eq	-4,76%	-9,92%	2,52E+01	5,16%	9,92%
Ionizing radiation E (interim)	CTUe	-4,99%	-9,99%	9,01E-05	4,99%	9,99%
Photochemical ozone formation	kg NMVOC eq	-5,29%	-10,00%	1,70E+00	4,71%	10,00%
Acidification	molc H+ eq	-5,61%	-10,28%	1,07E+01	4,67%	9,35%
Terrestrial eutrophication	molc N eq	-4,55%	-9,82%	1,10E+01	5,45%	10,00%
Freshwater eutrophication	kg P eq	-4,81%	-9,81%	1,04E-01	4,81%	9,62%
Marine eutrophication	kg N eq	-4,83%	-9,78%	8,69E-01	4,95%	9,78%
Freshwater ecotoxicity	CTUe	-4,57%	-9,14%	1,75E+03	5,14%	9,71%
Land Use	kg C deficit	-4,92%	-9,99%	6,91E+02	5,07%	9,99%
Water resource depletion	m3 water eq	-4,97%	-9,94%	3,42E+00	5,26%	10,23%
Mineral, fossil & ren resource depletion	kg Sb eq	-4,59%	-9,69%	1,96E-02	5,61%	10,71%

Results one parameter at a time - Sensitivity analysis

Impact category	Unidade	(+)10% H2SO4	(+)10% de Glucose	(+)10% de NaOH	(+)10% Na2CO3	Original value	% H2SO4	% Glucose	% NaOH	% Na2CO3
Climate change	kg CO2 eq	3,08E+02	3,13E+02	3,13E+02	3,13E+02	3,02E+02	1,99%	3,64%	3,64%	3,64%
Ozone depletion	kg CFC-11 eq	6,91E-05	6,95E-05	7,44E-05	6,90E-05	6,87E-05	0,58%	1,16%	8,30%	0,44%
Human Toxicity - non	CTUh	-6,19E-05	-7,41E-05	-6,07E-05	-6,04E-05	-6,31E-05	-1,90%	-17,43%	-3,80%	-4,28%
Human Toxicity - cancer	CTUh	1,14E-05	1,16E-05	1,17E-05	1,16E-05	1,13E-05	0,88%	2,65%	3,54%	2,65%
Particulate matter	kg PM2.5 eq	7,27E-01	6,97E-01	6,96E-01	7,01E-01	6,86E-01	5,98%	1,60%	1,46%	2,19%
Ionizing radiation HH	kBq U235 eq	2,58E+01	2,62E+01	2,67E+01	2,58E+01	2,52E+01	2,38%	3,97%	5,95%	2,38%
Ionizing radiation E	CTUe	9,19E-05	9,34E-05	9,48E-05	9,18E-05	9,01E-05	2,00%	3,66%	5,22%	1,89%
Photochemical ozone	kg NMVOC eq	1,80E+00	1,72E+00	1,73E+00	1,73E+00	1,70E+00	5,88%	1,18%	1,76%	1,76%
Acidification	molc H+ eq	1,14E+01	1,08E+01	1,07E+01	1,08E+01	1,07E+01	6,54%	0,93%	0,00%	0,93%
Terrestrial eutrophication	molc N eq	1,12E+01	1,16E+01	1,11E+01	1,13E+01	1,10E+01	1,82%	5,45%	0,91%	2,73%
Freshwater eutrophication	kg P eq	1,05E-01	1,07E-01	1,08E-01	1,07E-01	1,04E-01	0,96%	2,88%	3,85%	2,88%
Marine eutrophication	kg N eq	8,87E-01	9,19E-01	8,80E-01	8,80E-01	8,69E-01	2,07%	5,75%	1,27%	1,27%
Freshwater ecotoxicity	CTUe	1,78E+03	1,81E+03	1,79E+03	1,80E+03	1,75E+03	1,71%	3,43%	2,29%	2,86%
Land Use	kg C deficit	6,92E+02	7,50E+02	6,93E+02	6,99E+02	6,91E+02	0,14%	8,54%	0,29%	1,16%
Water resource depletion	m3 water eq	3,72E+00	3,41E+00	3,45E+00	3,48E+00	3,42E+00	8,77%	-0,29%	0,88%	1,75%
Mineral, fossil & ren	kg Sb eq	1,99E-02	1,98E-02	1,98E-02	2,12E-02	1,96E-02	1,53%	1,02%	1,02%	8,16%

SUPPLEMENTARY MATERIAL 14- Sensitivity analysis with ReCiPe midpoint H

DETRITUS - Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Scenario 1 (2023)								
Unity	Impact category	External recycling (90 t)	Intermediary transport (18000 tkm)	Sea transport (842.490 tkm)	Landfill (2.925 t)	Total	Avoided impact of external recycling	Net impact scenario 1
kg CO2 eq	Climate change	1,12E+05	3,23E+03	5,08E+03	2,21E+06	2,33E+06	-1,61E+05	2,17E+06
kg CFC11 eq	Ozone depletion	7,97E-02	1,48E-03	3,66E-03	1,42E-01	2,26E-01	-2,81E-01	-5,44E-02
kBq Co-60 eq	Ionising radiation	1,10E+04	2,52E+01	3,76E+01	2,84E+03	1,39E+04	-7,19E+03	6,69E+03
kg NOx eq	Fine particulate matter formation	2,37E+02	1,35E+01	9,22E+01	2,44E+02	5,87E+02	-1,37E+03	-7,81E+02
kg PM2.5 eq	Photochemical oxidant formation: terrestrial	2,72E+02	3,16E+00	3,24E+01	1,23E+02	4,30E+02	-3,97E+03	-3,54E+03
kg NOx eq	Photochemical oxidant formation: human	2,39E+02	1,36E+01	9,28E+01	2,47E+02	5,92E+02	-1,39E+03	-7,97E+02
kg SO2 eq	Terrestrial acidification	4,25E+02	8,26E+00	1,02E+02	2,54E+02	7,89E+02	-1,26E+04	-1,18E+04
kg P eq	Freshwater eutrophication	4,48E+01	6,27E-02	3,07E-02	4,43E+01	8,92E+01	-5,86E+02	-4,97E+02
kg N eq	Marine eutrophication	3,09E+01	4,44E-03	2,40E-03	2,40E+03	2,43E+03	-2,21E+01	2,41E+03
kg 1,4-DCB	Human toxicity: cancer	1,60E+05	5,28E+04	1,11E+04	3,54E+04	2,59E+05	-5,03E+07	-5,00E+07
kg 1,4-DCB	Human toxicity: non-cancer	4,44E+03	1,20E+01	3,01E+00	1,27E+06	1,27E+06	-4,79E+05	7,91E+05
kg 1,4-DCB	Terrestrial ecotoxicity	6,08E+03	4,30E+01	1,04E+01	1,66E+06	1,66E+06	-6,17E+05	1,05E+06
kg 1,4-DCB	Freshwater ecotoxicity	3,51E+03	7,37E+00	1,94E+01	4,49E+04	4,85E+04	-4,64E+04	2,07E+03
kg 1,4-DCB	Marine ecotoxicity	1,49E+05	8,79E+02	2,33E+02	2,71E+07	2,73E+07	-7,11E+06	2,02E+07
m2a crop eq	Land use	1,10E+03	1,45E+00	1,52E+00	4,23E+03	5,33E+03	-9,17E+03	-3,84E+03
kg Cu eq	Mineral resource scarcity	2,17E+02	4,63E-01	9,72E-02	8,30E+00	2,26E+02	-8,08E+04	-8,06E+04
kg oil eq	Fossil resource scarcity	2,39E+04	1,05E+03	1,52E+03	9,79E+03	3,62E+04	-3,61E+04	1,49E+02
m3	Water use	1,58E+03	1,05E+00	2,06E-01	1,72E-01	1,59E+03	-2,22E+03	-6,33E+02

Scenario 2 (2024)										
Unity	Impact category	External recycling (282 t)	Brazil recycling (47,1 t)	Intermediary transport (56.400 tkm)	Sea transport (2.639.7 tkm)	Landfill (2.809 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact scenario 2
kg CO2 eq	Climate change	3,46E+05	1,89E+04	9,94E+03	1,58E+04	2,09E+06	2.480.586,41	-500.283,27	-30.265,99	1,95E+06
kg CFC11 eq	Ozone depletion	2,47E-01	2,33E-02	4,58E-03	1,13E-02	1,35E-01	4,21E-01	-8,71E-01	-5,11E-02	-5,01E-01
kBq Co-60 eq	Ionising radiation	3,40E+04	9,21E+02	7,81E+01	1,17E+02	2,69E+03	3,78E+04	-2,23E+04	-1,76E+03	1,38E+04
kg NOx eq	Fine particulate matter formation	7,34E+02	2,69E+01	4,18E+01	2,86E+02	2,32E+02	1,32E+03	-4,24E+03	-2,65E+02	-3,18E+03
kg PM2.5 eq	Photochemical oxidant	8,43E+02	1,75E+03	9,79E+00	1,00E+02	1,16E+02	2,82E+03	-1,23E+04	-3,29E+02	-9,82E+03
kg NOx eq	Photochemical oxidant	7,39E+02	2,73E+01	4,22E+01	2,88E+02	2,35E+02	1,33E+03	-4,31E+03	-2,69E+02	-3,24E+03
kg SO2 eq	Terrestrial acidification	1,32E+03	1,68E+02	2,56E+01	3,16E+02	2,41E+02	2,07E+03	-3,91E+04	-1,01E+03	-3,80E+04
kg P eq	Freshwater eutrophication	1,39E+02	2,32E+00	1,94E-01	9,51E-02	4,21E+01	1,84E+02	-1,82E+03	-2,07E+01	-1,65E+03
kg N eq	Marine eutrophication	9,57E+01	8,43E+00	1,38E-02	7,43E-03	2,28E+03	2,38E+03	-6,84E+01	-2,06E+00	2,31E+03
kg 1,4-DCB	Human toxicity: cancer	4,97E+05	1,33E+04	1,64E+05	3,44E+04	3,35E+04	7,42E+05	-1,56E+08	-5,76E+05	-1,56E+08
kg 1,4-DCB	Human toxicity: non-cancer	1,38E+04	1,18E+03	3,73E+01	9,34E+00	1,20E+06	1,21E+06	-1,49E+06	-1,11E+04	-2,82E+05
kg 1,4-DCB	Terrestrial ecotoxicity	1,89E+04	1,64E+03	1,33E+02	3,23E+01	1,57E+06	1,59E+06	-1,91E+06	-1,43E+04	-3,38E+05
kg 1,4-DCB	Freshwater ecotoxicity	1,09E+04	1,99E+02	2,28E+01	6,02E+01	4,26E+04	5,38E+04	-1,44E+05	-1,62E+04	-1,06E+05
kg 1,4-DCB	Marine ecotoxicity	4,63E+05	2,74E+04	2,72E+03	7,22E+02	2,58E+07	2,63E+07	-2,20E+07	-1,55E+05	4,10E+06
m2a crop eq	Land use	3,40E+03	1,51E+03	4,51E+00	4,72E+00	4,01E+03	8,93E+03	-2,84E+04	-2,08E+03	-2,16E+04
kg Cu eq	Mineral resource scarcity	6,72E+02	3,99E+01	1,44E+00	3,01E-01	7,87E+00	7,22E+02	-2,50E+05	-2,28E+04	-2,73E+05
kg oil eq	Fossil resource scarcity	7,39E+04	3,27E+03	3,24E+03	4,70E+03	9,29E+03	9,44E+04	-1,12E+05	-6,88E+03	-2,42E+04
m3	Water use	4,91E+03	8,44E+02	3,24E+00	6,39E-01	1,63E+02	5,92E+03	-6,88E+03	-3,99E+02	-1,36E+03

Scenario 3 (2025)										
Unity	Impact category	External recycling (271 t)	Brazil recycling (135,7 t)	Intermediary transport(54.200 tkm)	Sea transport (2.536.8 tkm)	Landfill (2.786 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact Scenario 3
kg CO2 eq	Climate change	3,32E+05	8,87E+04	9,54E+03	1,51E+04	2,07E+06	2.515.682,78	-4,81E+05	-1,99E+05	1,84E+06
kg CFC11 eq	Ozone depletion	2,37E-01	1,19E-01	4,40E-03	1,09E-02	1,33E-01	5,04E-01	-8,36E-01	-3,35E-01	-6,67E-01
kBq Co-60 eq	Ionising radiation	3,27E+04	4,14E+03	7,50E+01	1,12E+02	2,67E+03	3,97E+04	-2,14E+04	-1,15E+04	6,75E+03
kg NOx eq	Fine particulate matter formation	7,05E+02	1,57E+02	4,02E+01	2,75E+02	2,29E+02	1,41E+03	-4,07E+03	-1,74E+03	-4,40E+03
kg PM2.5 eq	Photochemical oxidant	8,09E+02	5,21E+03	9,41E+00	9,64E+01	1,15E+02	6,24E+03	-1,18E+04	-2,16E+03	-7,74E+03
kg NOx eq	Photochemical oxidant	7,10E+02	1,60E+02	4,05E+01	2,76E+02	2,32E+02	1,42E+03	-4,14E+03	-1,76E+03	-4,48E+03
kg SO2 eq	Terrestrial acidification	1,26E+03	1,07E+03	2,46E+01	3,03E+02	2,38E+02	2,90E+03	-3,75E+04	-6,62E+03	-4,13E+04
kg P eq	Freshwater eutrophication	1,33E+02	1,44E+01	1,87E-01	9,14E-02	4,16E+01	1,90E+02	-1,75E+03	-1,36E+02	-1,69E+03
kg N eq	Marine eutrophication	9,19E+01	3,36E+01	1,32E-02	7,14E-03	2,26E+03	2,39E+03	-6,57E+01	-1,35E+01	2,31E+03
kg 1,4-DCB	Human toxicity: cancer	4,77E+05	7,49E+04	1,57E+05	3,30E+04	3,32E+04	7,75E+05	-1,50E+08	-3,78E+06	-1,53E+08
kg 1,4-DCB	Human toxicity: non-cancer	1,32E+04	3,78E+03	3,59E+01	8,97E+00	1,19E+06	1,21E+06	-1,43E+06	-7,30E+04	-2,94E+05
kg 1,4-DCB	Terrestrial ecotoxicity	1,81E+04	5,22E+03	1,28E+02	3,11E+01	1,56E+06	1,58E+06	-1,84E+06	-9,40E+04	-3,49E+05
kg 1,4-DCB	Freshwater ecotoxicity	1,05E+04	1,12E+03	2,19E+01	5,79E+01	4,21E+04	5,37E+04	-1,38E+05	-1,06E+05	-1,90E+05
kg 1,4-DCB	Marine ecotoxicity	4,45E+05	8,60E+04	2,62E+03	6,93E+02	2,55E+07	2,60E+07	-2,12E+07	-1,02E+06	3,84E+06
m2a crop eq	Land use	3,27E+03	9,35E+03	4,33E+00	4,53E+00	3,97E+03	1,66E+04	-2,73E+04	-1,36E+04	-2,43E+04
kg Cu eq	Mineral resource scarcity	6,46E+02	2,58E+02	1,38E+00	2,89E-01	7,79E+00	9,14E+02	-2,41E+05	-1,50E+05	-3,89E+05
kg oil eq	Fossil resource scarcity	7,10E+04	1,89E+04	3,11E+03	4,52E+03	9,19E+03	1,07E+05	-1,07E+05	-4,51E+04	-4,58E+04
m3	Water use	4,72E+03	4,51E+03	3,11E+00	6,14E-01	1,62E+02	9,39E+03	-6,61E+03	-2,62E+03	1,66E+02

Scenario 4 (2026)										
Unity	Impact category	External recycling (411 t)	Brazil recycling (1.232,4 t)	Intermediary transport(82.200 tkm)	Sea transport (3.847.3 tkm)	Landfill (1.643 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact Scenario 4
kg CO2 eq	Climate change	5,01E+05	8,05E+05	1,44E+04	2,28E+04	1,22E+06	2,56E+06	-7,24E+05	-1,80E+06	3,81E+04
kg CFC11 eq	Ozone depletion	3,58E-01	1,08E+00	6,63E-03	1,64E-02	7,85E-02	1,53E+00	-1,26E+00	-3,04E+00	-2,76E+00
kBq Co-60 eq	Ionising radiation	4,93E+04	3,75E+04	1,13E+02	1,69E+02	1,57E+03	8,87E+04	-3,23E+04	-1,04E+05	-4,81E+04
kg NOx eq	Fine particulate matter formation	1,06E+03	1,43E+03	6,06E+01	4,14E+02	1,35E+02	3,10E+03	-6,14E+03	-1,58E+04	-1,88E+04
kg PM2.5 eq	Photochemical oxidant	1,22E+03	4,72E+04	1,42E+01	1,45E+02	6,79E+01	4,87E+04	-1,78E+04	-1,96E+04	1,13E+04
kg NOx eq	Photochemical oxidant	1,07E+03	1,45E+03	6,11E+01	4,16E+02	1,37E+02	3,13E+03	-6,23E+03	-1,60E+04	-1,91E+04
kg SO2 eq	Terrestrial acidification	1,91E+03	9,66E+03	3,71E+01	4,57E+02	1,40E+02	1,22E+04	-5,66E+04	-6,01E+04	-1,04E+05
kg P eq	Freshwater eutrophication	2,01E+02	1,31E+02	2,81E-01	1,38E-01	2,45E+01	3,57E+02	-2,63E+03	-1,23E+03	-3,51E+03
kg N eq	Marine eutrophication	1,39E+02	3,05E+02	1,99E-02	1,08E-02	1,33E+03	1,77E+03	-9,90E+01	-1,23E+02	1,55E+03
kg 1,4-DCB	Human toxicity: cancer	7,19E+05	6,79E+05	2,37E+05	4,98E+04	1,95E+04	1,70E+06	-2,26E+08	-3,43E+07	-2,58E+08
kg 1,4-DCB	Human toxicity: non-cancer	1,99E+04	3,43E+04	5,41E+01	1,35E+01	6,99E+05	7,53E+05	-2,15E+06	-6,62E+05	-2,06E+06
kg 1,4-DCB	Terrestrial ecotoxicity	2,73E+04	4,73E+04	1,93E+02	4,68E+01	9,17E+05	9,92E+05	-2,77E+06	-8,52E+05	-2,63E+06
kg 1,4-DCB	Freshwater ecotoxicity	1,58E+04	1,01E+04	3,31E+01	8,72E+01	2,48E+04	5,08E+04	-2,08E+05	-9,61E+05	-1,12E+06
kg 1,4-DCB	Marine ecotoxicity	6,71E+05	7,80E+05	3,95E+03	1,04E+03	1,50E+07	1,65E+07	-3,19E+07	-9,21E+06	-2,47E+07
m2a crop eq	Land use	4,93E+03	8,48E+04	6,53E+00	6,83E+00	2,34E+03	9,21E+04	-4,12E+04	-1,23E+05	-7,25E+04
kg Cu eq	Mineral resource scarcity	9,74E+02	2,34E+03	2,08E+00	4,36E-01	4,59E+00	3,32E+03	-3,63E+05	-1,36E+06	-1,72E+06
kg oil eq	Fossil resource scarcity	1,07E+05	1,71E+05	4,69E+03	6,81E+03	5,42E+03	2,95E+05	-1,62E+05	-4,09E+05	-2,76E+05
m3	Water use	7,11E+03	4,09E+04	4,69E+00	9,25E-01	9,53E+01	4,81E+04	-9,96E+03	-2,38E+04	1,44E+04

SUPPLEMENTARY MATERIAL 15 - Reverse Logisitics - sensitivity analysis

DETRITUS - Detritus – Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Content:

1. Calculation method and results of internal Reverse Logistics - intermediary transport
2. Change in scenarios results from internal RL

Total of cities included in RL /year in WEEE Reverse Logistics Sector Agreement - Decree nº 10.240/2020				
Year	2023	2024	2025	2026
State	Year 3	Year 4	Year 5	Year 6
AC	1	1	2	2
AL	1	2	2	2
AM	2	3	5	5
AP	1	1	2	2
BA	7	15	23	23
CE	4	8	11	11
DF	1	1	1	1
ES	6	8	10	10
GO	6	10	16	16
MA	3	6	13	13
MG	19	32	44	44
MS	2	4	5	5
MT	2	3	7	7
PA	4	7	20	20
PB	4	4	5	5
PE	9	15	19	19
PI	1	1	2	2
PR	10	21	27	27
RJ	20	28	33	33
RN	4	4	4	4
RO	1	1	5	5
RR	1	1	1	1
RS	13	19	25	25
SC	8	14	15	15
SE	2	3	5	5
SP	53	81	95	95
TO	1	1	3	3
TOTAL	186	294	400	400

Reference
Brazil. (2020). WEEE Reverse Logistics Sector Agreement. Decree nº 10.240/2020.

Ecoinvent process used to calculate intermediary transport environmental impact
Transport, freight, lorry 7.5-16 metric ton, euro4 {RoW}| market for transport, freight, lorry 7.5-16 metric ton, EURO4 | Cut-off, U

Assumptions

1. As the WEEE RL implementation targets defined by Law (Brazil, 2020) establishes the gradual implementation of RL in the states but does not provide the specific cities for each year, only the number of cities served each year, the cities were added to RL according to population, with the most populous cities being served first until reaching a total of 400 cities served.
2. For the year 2026, as there was no data on cities served, the same number of cities as in 2025 (400 cities) was assumed.
3. Point-to-point collection transport within the cities has not been included due to the lack of data on average distances travelled in each of the cities. Therefore, what is included in the calculations is intermediate transport, after collection, from each generating city to the pretreatment centre (here considered to be the city of São Paulo)

Total of 186 municipalities included in RL					Smartphones waste generation	Laptops waste generation				Target RL - smartphones	Target RL - laptops		RL-WEEE				RL-LIBs
Nº	State	City	Population	Distance to São Paulo city and state	Units (2023)	Units (2023)	PERCAPITA-SMARTPHONES BY CITY	PERCAPITA-LAPTOPS BY CITY	WEIGHT	6%	6%	Total WEEE 2023	tkm/year/city WEEE	Allocation tkm/year for LIBs (% weight of smartphones 27,3%)	Allocation tkm/year for LIBs (% weight of laptops (9,34%)	Total LIBs weight	tkm/year/city for LIBs
1	AC	Rio Branco	401.155	3.500	42.016.137	4.910.199	25,50	52,28	77,77	2	3	5	16.333	0,42	0,29	0,71	2.487,16
2	AL	Maceió	1.012.382	2.408			64,35	131,93	196,28	4	8	12	28.358	1,05	0,74	1,79	4.318,42
3	AM	Manaus	2.145.444	3.876	Mass (t)	Mass (t)	136,37	279,58	415,95	8	17	25	96.734	2,23	1,57	3,80	14.730,75
4	AM	Parintins	113.168	2.560	6.493	13.312	7,19	14,75	21,94	0	1	1	3.370	0,12	0,08	0,20	513,20
5	AP	Macapá	493.634	3.404			31,38	64,33	95,70	2	4	6	19.547	0,51	0,36	0,87	2.976,59
6	BA	Salvador	2.857.329	1.961	Percapita unit	Percapita unit	181,62	372,35	553,97	11	22	33	65.180	2,97	2,09	5,06	9.925,71
7	BA	Feira de Santana	609.913	1.875	0,4113083635	0,04806738876	38,77	79,48	118,25	2	5	7	13.303	0,64	0,45	1,08	2.025,78
8	BA	Vitória da Conquista	338.885	1.600			21,54	44,16	65,70	1	3	4	6.307	0,35	0,25	0,60	960,50
9	BA	Camaçari	293.723	1.950	Percapita weight	Percapita weight	18,67	38,28	56,95	1	2	3	6.663	0,31	0,21	0,52	1.014,60
10	BA	Juazeiro	215.183	2.201	0,00006356189255	0,0001303150953	13,68	28,04	41,72	1	2	3	5.509	0,22	0,16	0,38	838,98
11	BA	Itabuna	212.740	1.815	t/people/year	t/people/year	13,52	27,72	41,25	1	2	2	4.492	0,22	0,16	0,38	683,99
12	BA	Lauro de Freitas	195.095	1.956			12,40	25,42	37,82	1	2	2	4.439	0,20	0,14	0,35	675,99
13	CE	Fortaleza	2.643.247	2.904			168,01	344,45	512,46	10	21	31	89.292	2,75	1,93	4,68	13.597,47
14	CE	Caucaia	363.982	3.081			23,14	47,43	70,57	1	3	4	13.045	0,38	0,27	0,64	1.986,53
15	CE	Juazeiro do Norte	271.926	2.456			17,28	35,44	52,72	1	2	3	7.769	0,28	0,20	0,48	1.183,05
16	CE	Maracanaú	226.128	3.090			14,37	29,47	43,84	1	2	3	8.128	0,24	0,17	0,40	1.237,76
17	DF	Brasília	2.974.703	1.008			189,08	387,65	576,73	11	23	35	34.880	3,10	2,17	5,27	5.311,63
18	ES	Serra	507.598	977			32,26	66,15	98,41	2	4	6	5.769	0,53	0,37	0,90	878,49
19	ES	Vila Velha	486.208	945			30,90	63,36	94,26	2	4	6	5.345	0,51	0,36	0,86	813,91
20	ES	Cariacica	378.603	948			24,06	49,34	73,40	1	3	4	4.175	0,39	0,28	0,67	635,79
21	ES	Vitória	358.267	946			22,77	46,69	69,46	1	3	4	3.943	0,37	0,26	0,63	600,37
22	ES	Cachoeiro de Itapemirim	207.324	828			13,18	27,02	40,20	1	2	2	1.997	0,22	0,15	0,37	304,09
23	ES	Linhares	170.364	1.086			10,83	22,20	33,03	1	1	2	2.152	0,18	0,12	0,30	327,74
24	GO	Goiânia	1.495.705	930			95,07	194,91	289,98	6	12	17	16.181	1,56	1,09	2,65	2.464,07
25	GO	Aparecida de Goiânia	565.957	911			35,97	73,75	109,73	2	4	7	5.998	0,59	0,41	1,00	913,33
26	GO	Anápolis	381.970	982			24,28	49,78	74,06	1	3	4	4.363	0,40	0,28	0,68	664,45
27	GO	Rio Verde	229.651	927			14,60	29,93	44,52	1	2	3	2.476	0,24	0,17	0,41	377,11
28	GO	Águas Lindas de Goiás	207.070	1.035			13,16	26,98	40,15	1	2	2	2.493	0,22	0,15	0,37	379,65
29	GO	Luziânia	205.023	952			13,03	26,72	39,75	1	2	2	2.270	0,21	0,15	0,36	345,75
30	MA	São Luís	1.094.667	2.935			69,58	142,65	212,23	4	9	13	37.374	1,14	0,80	1,94	5.691,33
31	MA	Imperatriz	258.016	2.330			16,40	33,62	50,02	1	2	3	6.993	0,27	0,19	0,46	1.064,94
32	MA	São José de Ribamar	176.321	2.947			11,21	22,98	34,18	1	1	2	6.045	0,18	0,13	0,31	920,47
33	MG	Belo Horizonte	2.501.576	584			159,00	325,99	485,00	10	20	29	16.994	2,60	1,83	4,43	2.587,92
34	MG	Uberlândia	683.247	587			43,43	89,04	132,47	3	5	8	4.665	0,71	0,50	1,21	710,46
35	MG	Contagem	659.070	573			41,89	85,89	127,78	3	5	8	4.393	0,69	0,48	1,17	668,98
36	MG	Juiz de Fora	564.310	508			35,87	73,54	109,41	2	4	7	3.335	0,59	0,41	1,00	507,81
37	MG	Betim	432.575	590			27,50	56,37	83,87	2	3	5	2.969	0,45	0,32	0,77	452,10
38	MG	Montes Claros	404.804	980			25,73	52,75	78,48	2	3	5	4.615	0,42	0,30	0,72	702,74
39	MG	Ribeirão das Neves	331.045	598			21,04	43,14	64,18	1	3	4	2.303	0,34	0,24	0,59	350,68
40	MG	Uberaba	330.361	482			21,00	43,05	64,05	1	3	4	1.852	0,34	0,24	0,59	282,07
41	MG	Governador Valadares	278.685	894			17,71	36,32	54,03	1	2	3	2.898	0,29	0,20	0,49	441,34
42	MG	Ipatinga	261.344	792			16,61	34,06	50,67	1	2	3	2.408	0,27	0,19	0,46	366,66
43	MG	Sete Lagoas	237.286	634			15,08	30,92	46,00	1	2	3	1.750	0,25	0,17	0,42	266,49
44	MG	Divinópolis	235.977	511			15,00	30,75	45,75	1	2	3	1.403	0,25	0,17	0,42	213,61
45	MG	Santa Luzia	218.147	599			13,87	28,43	42,29	1	2	3	1.520	0,23	0,16	0,39	231,47
46	MG	Ibirité	179.015	572			11,38	23,33	34,71	1	1	2	1.191	0,19	0,13	0,32	181,39
47	MG	Poços de Caldas	166.111	258			10,56	21,65	32,21	1	1	2	499	0,17	0,12	0,29	75,92
48	MG	Patos de Minas	150.833	721			9,59	19,66	29,24	1	1	2	1.265	0,16	0,11	0,27	192,64
49	MG	Pouso Alegre	148.862	211			9,46	19,40	28,86	1	1	2	365	0,15	0,11	0,26	55,64
50	MG	Teófilo Otoni	140.235	1.024			8,91	18,27	27,19	1	1	2	1.670	0,15	0,10	0,25	254,38
51	MG	Barbacena	136.392	526			8,67	17,77	26,44	1	1	2	835	0,14	0,10	0,24	127,09
52	MS	Campo Grande	885.711	987			56,30	115,42	171,72	3	7	10	10.169	0,92	0,65	1,57	1.548,58
53	MS	Dourados	220.965	982			14,04	28,80	42,84	1	2	3	2.524	0,23	0,16	0,39	384,38
54	MT	Cuiabá	607.153	1.529			38,59	79,12	117,71	2	5	7	10.799	0,63	0,44	1,08	1.644,48
55	MT	Várzea Grande	282.009	1.535			17,93	36,75	54,68	1	2	3	5.036	0,29	0,21	0,50	766,82
56	PA	Belém	1.485.732	2.895			94,44	193,61	288,05	6	12	17	50.034	1,55	1,09	2,63	7.619,26
57	PA	Ananindeua	525.566	2.877			33,41	68,49	101,90	2	4	6	17.589	0,55	0,38	0,93	2.678,50
58	PA	Santarém	302.667	3.295			19,24	39,44	58,68	1	2	4	11.601	0,32	0,22	0,54	1.766,63
59	PA	Marabá	275.086	2.346			17,48	35,85	53,33	1	2	3	7.507	0,29	0,20	0,49	1.143,20
60	PB	João Pessoa	800.323	2.748			50,87	104,29	155,16	3	6	9	25.583	0,83	0,58	1,42	3.895,88
61	PB	Campina Grande	407.472	2.647			25,90	53,10	79,00	2	3	5	12.547	0,42	0,30	0,72	1.910,63
62	PB	Santa Rita	135.807	2.753			8,63	17,70	26,33	1	1	2	4.349	0,14	0,10	0,24	662,30
63	PB	Patos	106.984	2.609			6,80	13,94	20,74	0	1	1	3.247	0,11	0,08	0,19	494,44
64	PE	Recife	1.637.834	2.636			104,10	213,43	317,54	6	13	19	50.222	1,71	1,20	2,90	7.647,85
65	PE	Jaboatão dos Guararapes	697.636	2.625			44,34	90,91	135,26	3	5	8	21.303	0,73	0,51	1,24	3.244,01
66	PE	Olinda	391.835	2.645			24,91	51,06	75,97	1	3	5	12.056	0,41	0,29	0,69	1.835,92
67	PE	Caruaru	356.872	2.535			22,68	46,51	69,19	1	3	4	10.524	0,37	0,26	0,63	1.602,56
68	PE	Petrolina	343.865	2.206			21,86	44,81	66,67	1	3	4	8.824	0,36	0,25	0,61	1.343,75
69	PE	Paulista	329.117	2.660			20,92	42,89	63,81	1	3	4	10.184	0,34	0,24	0,58	1.550,80
70	PE	Cabo de Santo Agostinho	205.112	2.601			13,04	26,73	39,77	1	2	2	6.206	0,21	0,15	0,36	945,05
71	PE	Camaragibe	156.736	2.641			9,96	20,43	30,39	1	1	2	4.815	0,16	0,11	0,28	733,27
72	PE	Garanhuns	138.983	2.408			8,83	18,11	26,95	1	1	2	3.893	0,14	0,10	0,25	592,85
73	PI	Teresina	861.442	2.654			54,75	112,26	167,01	3	7	10	26.595	0,90	0,63	1,53	4.049,96
74	PR	Curitiba	1.917.185	408			121,86	249,84	371,70	7	15	22	9.099	2,00	1,40	3,40	1.385,63
75	PR	Londrina	563.943	537			35,85	73,49	109,34	2	4	7	3.523	0,59	0,41	1,00	536,46

76	PR	Maringá	417.010	649	26,51	54,34	80,85	2	3	5	3.148	0,43	0,30	0,74	479,42
77	PR	Ponta Grossa	348.043	516	22,12	45,36	67,48	1	3	4	2.089	0,36	0,25	0,62	318,13
78	PR	Cascavel	324.476	929	20,62	42,28	62,91	1	3	4	3.507	0,34	0,24	0,57	533,98
79	PR	São José dos Pinhais	317.476	409	20,18	41,37	61,55	1	2	4	1.510	0,33	0,23	0,56	230,02
80	PR	Foz do Iguaçu	258.823	1.058	16,45	33,73	50,18	1	2	3	3.185	0,27	0,19	0,46	485,08
81	PR	Colombo	240.840	394	15,31	31,39	46,69	1	2	3	1.104	0,25	0,18	0,43	168,09
82	PR	Guarapuava	180.334	670	11,46	23,50	34,96	1	1	2	1.405	0,19	0,13	0,32	214,03
83	PR	Paranaguá	153.666	435	9,77	20,02	29,79	1	1	2	778	0,16	0,11	0,27	118,41
84	RJ	Rio de Janeiro	6.688.927	444	425,16	871,67	1.296,83	26	52	78	34.548	6,96	4,88	11,85	5.260,94
85	RJ	São Gonçalo	1.077.687	462	68,50	140,44	208,94	4	8	13	5.792	1,12	0,79	1,91	881,98
86	RJ	Duque de Caxias	914.383	422	58,12	119,16	177,28	3	7	11	4.489	0,95	0,67	1,62	683,54
87	RJ	Nova Iguaçu	818.875	408	52,05	106,71	158,76	3	6	10	3.886	0,85	0,60	1,45	591,84
88	RJ	Niterói	511.786	449	32,53	66,69	99,22	2	4	6	2.673	0,53	0,37	0,91	407,06
89	RJ	Belford Roxo	508.614	410	32,33	66,28	98,61	2	4	6	2.426	0,53	0,37	0,90	369,40
90	RJ	Campos dos Goytacazes	503.424	709	32,00	65,60	97,60	2	4	6	4.152	0,52	0,37	0,89	632,27
91	RJ	São João de Meriti	471.888	417	29,99	61,49	91,49	2	4	5	2.289	0,49	0,34	0,84	348,58
92	RJ	Petrópolis	305.687	458	19,43	39,84	59,27	1	2	4	1.629	0,32	0,22	0,54	248,01
93	RJ	Volta Redonda	271.998	327	17,29	35,45	52,73	1	2	3	1.035	0,28	0,20	0,48	157,56
94	RJ	Macaé	251.631	618	15,99	32,79	48,79	1	2	3	1.809	0,26	0,18	0,45	275,47
95	RJ	Magé	243.657	454	15,49	31,75	47,24	1	2	3	1.287	0,25	0,18	0,43	195,96
96	RJ	Itaboraí	238.695	480	15,17	31,11	46,28	1	2	3	1.333	0,25	0,17	0,42	202,96
97	RJ	Cabo Frio	222.528	583	14,14	29,00	43,14	1	2	3	1.509	0,23	0,16	0,39	229,81
98	RJ	Angra dos Reis	200.407	405	12,74	26,12	38,85	1	2	2	944	0,21	0,15	0,36	143,78
99	RJ	Nova Friburgo	190.084	546	12,08	24,77	36,85	1	1	2	1.207	0,20	0,14	0,34	183,85
100	RJ	Barra Mansa	183.976	312	11,69	23,97	35,67	1	1	2	668	0,19	0,13	0,33	101,68
101	RJ	Teresópolis	180.886	491	11,50	23,57	35,07	1	1	2	1.033	0,19	0,13	0,32	157,33
102	RJ	Mesquita	175.620	409	11,16	22,89	34,05	1	1	2	836	0,18	0,13	0,31	127,24
103	RJ	Nilópolis	162.269	416	10,31	21,15	31,46	1	1	2	785	0,17	0,12	0,29	119,58
104	RN	Natal	877.640	3.075	55,78	114,37	170,15	3	7	10	31.393	0,91	0,64	1,55	4.780,63
105	RN	Mossoró	294.076	2.766	18,69	38,32	57,01	1	2	3	9.462	0,31	0,21	0,52	1.440,91
106	RN	Parnamirim	255.793	3.055	16,26	33,33	49,59	1	2	3	9.090	0,27	0,19	0,45	1.384,28
107	RN	São Gonçalo do Amarante	101.102	3.079	6,43	13,18	19,60	0	1	1	3.621	0,11	0,07	0,18	551,43
108	RO	Porto Velho	519.531	2.987	33,02	67,70	100,73	2	4	6	18.052	0,54	0,38	0,92	2.748,97
109	RR	Boa Vista	375.374	4.657	23,86	48,92	72,78	1	3	4	20.335	0,39	0,27	0,66	3.096,67
110	RS	Porto Alegre	1.479.101	1.130	94,01	192,75	286,76	6	12	17	19.443	1,54	1,08	2,62	2.960,74
111	RS	Caxias do Sul	504.069	977	32,04	65,69	97,73	2	4	6	5.729	0,52	0,37	0,89	872,39
112	RS	Canoas	344.957	1.128	21,93	44,95	66,88	1	3	4	4.526	0,36	0,25	0,61	689,28
113	RS	Pelotas	341.648	1.380	21,72	44,52	66,24	1	3	4	5.484	0,36	0,25	0,61	835,18
114	RS	Santa Maria	280.505	1.258	17,83	36,55	54,38	1	2	3	4.105	0,29	0,20	0,50	625,09
115	RS	Gravataí	279.398	1.105	17,76	36,41	54,17	1	2	3	3.591	0,29	0,20	0,49	546,90
116	RS	Viamão	254.101	1.128	16,15	33,11	49,26	1	2	3	3.334	0,26	0,19	0,45	507,74
117	RS	Novo Hamburgo	246.452	1.143	15,66	32,12	47,78	1	2	3	3.277	0,26	0,18	0,44	499,00
118	RS	São Leopoldo	234.947	1.134	14,93	30,62	45,55	1	2	3	3.099	0,24	0,17	0,42	471,96
119	RS	Rio Grande	210.005	1.352	13,35	27,37	40,72	1	2	2	3.303	0,22	0,15	0,37	502,96
120	RS	Alvorada	209.213	1.120	13,30	27,26	40,56	1	2	2	2.726	0,22	0,15	0,37	415,08
121	RS	Passo Fundo	201.767	957	12,82	26,29	39,12	1	2	2	2.246	0,21	0,15	0,36	342,05
122	RS	Sapucaia do Sul	140.311	1.124	8,92	18,28	27,20	1	1	2	1.835	0,15	0,10	0,25	279,37
123	SC	Joinville	583.144	583	37,07	75,99	113,06	2	5	7	3.955	0,61	0,43	1,03	602,24
124	SC	Florianópolis	492.977	758	31,33	64,24	95,58	2	4	6	4.347	0,51	0,36	0,87	661,94
125	SC	Blumenau	352.460	637	22,40	45,93	68,33	1	3	4	2.612	0,37	0,26	0,62	397,72
126	SC	São José	242.927	746	15,44	31,66	47,10	1	2	3	2.108	0,25	0,18	0,43	321,02
127	SC	Chapecó	216.654	879	13,77	28,23	42,00	1	2	3	2.215	0,23	0,16	0,38	337,35
128	SC	Itajaí	215.895	662	13,72	28,13	41,86	1	2	3	1.663	0,22	0,16	0,38	253,18
129	SC	Criciúma	213.023	938	13,54	27,76	41,30	1	2	2	2.324	0,22	0,16	0,38	353,96
130	SC	Jaraguá do Sul	174.158	571	11,07	22,70	33,77	1	1	2	1.157	0,18	0,13	0,31	176,16
131	SE	Aracaju	648.939	2.155	41,25	84,57	125,81	2	5	8	16.268	0,68	0,47	1,15	2.477,28
132	SE	Nossa Senhora do Socorro	181.503	2.153	11,54	23,65	35,19	1	1	2	4.546	0,19	0,13	0,32	692,23
133	SP	São Paulo	12.176.866		773,98	1586,83	2.360,81	46	95	142	0	12,68	8,89	21,57	0,00
134	SP	Guarulhos	1.365.899	20	86,82	178,00	264,82	5	11	16	318	1,42	1,00	2,42	48,39
135	SP	Campinas	1.194.094	99	75,90	155,61	231,51	5	9	14	1.375	1,24	0,87	2,12	209,41
136	SP	São Bernardo do Campo	833.240	22,7	52,96	108,58	161,55	3	7	10	220	0,87	0,61	1,48	33,51
137	SP	Santo André	716.109	23,7	45,52	93,32	138,84	3	6	8	197	0,75	0,52	1,27	30,06
138	SP	São José dos Campos	713.943	97,4	45,38	93,04	138,42	3	6	8	809	0,74	0,52	1,26	123,18
139	SP	Osasco	696.850	23,4	44,29	90,81	135,10	3	5	8	190	0,73	0,51	1,23	28,89
140	SP	Ribeirão Preto	694.534	316	44,15	90,51	134,65	3	5	8	2.553	0,72	0,51	1,23	388,78
141	SP	Sorocaba	671.186	104	42,66	87,47	130,13	3	5	8	812	0,70	0,49	1,19	123,65
142	SP	Mauá	468.148	27,1	29,76	61,01	90,76	2	4	5	148	0,49	0,34	0,83	22,47
143	SP	São José do Rio Preto	456.245	440	29,00	59,46	88,46	2	4	5	2.335	0,48	0,33	0,81	355,61
144	SP	Mogi das Cruzes	440.769	63,7	28,02	57,44	85,45	2	3	5	327	0,46	0,32	0,78	49,74
145	SP	Santos	432.957	81,2	27,52	56,42	83,94	2	3	5	409	0,45	0,32	0,77	62,28
146	SP	Diadema	420.934	22,6	26,76	54,85	81,61	2	3	5	111	0,44	0,31	0,75	16,85
147	SP	Jundiaí	414.810	58,8	26,37	54,06	80,42	2	3	5	284	0,43	0,30	0,73	43,21
148	SP	Piracicaba	400.949	157	25,49	52,25	77,73	2	3	5	732	0,42	0,29	0,71	111,51
149	SP	Carapicuíba	398.611	30	25,34	51,95	77,28	2	3	5	139	0,42	0,29	0,71	21,18
150	SP	Bauru	374.272	332	23,79	48,77	72,56	1	3	4	1.445	0,39	0,27	0,66	220,11
151	SP	Itaquaquecetuba	366.519	43,5	23,30	47,76	71,06	1	3	4	185	0,38	0,27	0,65	28,24
152	SP	São Vicente	363.173	73	23,08	47,33	70,41	1	3	4	308	0,38	0,27	0,64	46,96
153	SP	Franca	350.400	400	22,27	45,66	67,93	1	3	4	1.630	0,36	0,26	0,62	248,28
154	SP	Praia Grande	319.146	77,6	20,29	41,59	61,88	1	2	4	288	0,33	0,23	0,57	43,87

155	SP	Guarujá	318.107	98,9	20,22	41,45	61,67	1	2	4	366	0,33	0,23	0,56	55,73
156	SP	Taubaté	311.854	140	19,82	40,64	60,46	1	2	4	508	0,32	0,23	0,55	77,34
157	SP	Limeira	303.682	163	19,30	39,57	58,88	1	2	4	576	0,32	0,22	0,54	87,69
158	SP	Suzano	294.638	51,7	18,73	38,40	57,12	1	2	3	177	0,31	0,22	0,52	26,98
159	SP	Taboão da Serra	285.570	18,9	18,15	37,21	55,37	1	2	3	63	0,30	0,21	0,51	9,56
160	SP	Sumaré	278.571	119	17,71	36,30	54,01	1	2	3	386	0,29	0,20	0,49	58,72
161	SP	Barueri	271.306	31,7	17,24	35,36	52,60	1	2	3	100	0,28	0,20	0,48	15,24
162	SP	Embu das Artes	270.843	31,1	17,22	35,29	52,51	1	2	3	98	0,28	0,20	0,48	14,92
163	SP	São Carlos	249.415	234	15,85	32,50	48,36	1	2	3	679	0,26	0,18	0,44	103,39
164	SP	Indaiatuba	246.908	103	15,69	32,18	47,87	1	2	3	296	0,26	0,18	0,44	45,05
165	SP	Cotia	244.694	34	15,55	31,89	47,44	1	2	3	97	0,25	0,18	0,43	14,74
166	SP	Marília	237.130	437	15,07	30,90	45,97	1	2	3	1.205	0,25	0,17	0,42	183,57
167	SP	Americana	237.112	129	15,07	30,90	45,97	1	2	3	356	0,25	0,17	0,42	54,18
168	SP	Itapevi	234.352	42,6	14,90	30,54	45,44	1	2	3	116	0,24	0,17	0,42	17,68
169	SP	Araraquara	233.744	277	14,86	30,46	45,32	1	2	3	753	0,24	0,17	0,41	114,69
170	SP	Jacareí	231.863	89,9	14,74	30,22	44,95	1	2	3	242	0,24	0,17	0,41	36,92
171	SP	Hortolândia	227.353	115	14,45	29,63	44,08	1	2	3	304	0,24	0,17	0,40	46,32
172	SP	Presidente Prudente	227.072	558	14,43	29,59	44,02	1	2	3	1.474	0,24	0,17	0,40	224,45
173	SP	Rio Claro	204.797	188	13,02	26,69	39,71	1	2	2	448	0,21	0,15	0,36	68,20
174	SP	Araçatuba	195.874	522	12,45	25,53	37,98	1	2	2	1.189	0,20	0,14	0,35	181,12
175	SP	Santa Bárbara d'Oeste	192.536	139	12,24	25,09	37,33	1	2	2	311	0,20	0,14	0,34	47,41
176	SP	Ferraz de Vasconcelos	191.993	32	12,20	25,02	37,22	1	2	2	71	0,20	0,14	0,34	10,88
177	SP	Francisco Morato	174.008	47,7	11,06	22,68	33,74	1	1	2	97	0,18	0,13	0,31	14,70
178	SP	Itapecerica da Serra	173.672	36,7	11,04	22,63	33,67	1	1	2	74	0,18	0,13	0,31	11,29
179	SP	Itu	172.268	103	10,95	22,45	33,40	1	1	2	206	0,18	0,13	0,31	31,43
180	SP	Bragança Paulista	166.753	87,5	10,60	21,73	32,33	1	1	2	170	0,17	0,12	0,30	25,85
181	SP	Pindamonhangaba	166.475	157	10,58	21,69	32,28	1	1	2	304	0,17	0,12	0,29	46,30
182	SP	Itapetininga	162.231	180	10,31	21,14	31,45	1	1	2	340	0,17	0,12	0,29	51,73
183	SP	São Caetano do Sul	160.275	12,7	10,19	20,89	31,07	1	1	2	24	0,17	0,12	0,28	3,61
184	SP	Franco da Rocha	152.433	43,3	9,69	19,86	29,55	1	1	2	77	0,16	0,11	0,27	11,69
185	SP	Mogi Guaçu	150.713	162	9,58	19,64	29,22	1	1	2	284	0,16	0,11	0,27	43,25
186	TO	Palmas	291.855	1.814	18,55	38,03	56,58	1	2	3	6.159	0,30	0,21	0,52	937,84
			102.152.402		6.493,00	13312,00	19.805,00	390	799	1.188	1.235.349,70	106,36	74,60	180,96	188.120,57

Total of 294 municipalities included in RL					Smartphones waste generation	Laptops waste generation				Target RL - smartphones	Target RL - laptops		RL-WEEE				RL-LIBs
Nº	State	City	Population (peoples)	Distance to São Paulo city and state (km)	Units (2024)	Units (2024)	PERCAPITA-SMARTPHONES BY CITY	PERCAPITA-LAPTOPS BY CITY	WEIGHT	12%	12%	Total WEEE 2024	tkm/year/city WEEE	Allocation tkm/year for LIBs (% weight of smartphones 27,3%)	Allocation tkm/year for LIBs (% weight of laptops (9,34%)	Total LIBs weight	tkm/year/city for LIBs
1	AC	Rio Branco	401.155	3.500	42.840.959	5.255.456	22,88	49,24	72,13	3	6	9	30.294	0,75	0,55	1,30	4,56E+14
2	AL	Maceió	1.012.382	2.408			57,75	124,28	182,03	7	15	22	52.599	1,89	1,39	3,28	7,91E+03
3	AL	Arapiraca	230.417	2.306	Mass (t)	Mass (t)	13,14	28,29	41,43	2	3	5	11.464	0,43	0,32	0,75	1,72E+03
4	AM	Manaus	2.145.444	3.876	6.621	14.248	122,39	263,37	385,75	15	32	46	179.422	4,01	2,95	6,96	2,70E+04
5	AM	Parintins	113.168	2.560			6,46	13,89	20,35	1	2	2	6.251	0,21	0,16	0,37	9,40E+02
6	AM	Itacoatiara	99.955	4.143	Percapita unit	Percapita unit	5,70	12,27	17,97	1	1	2	8.935	0,19	0,14	0,32	1,34E+03
7	AP	Macapá	493.634	3.404	0,3691052214	0,04527948136	28,16	60,60	88,76	3	7	11	36.255	0,92	0,68	1,60	5,45E+03
8	BA	Salvador	2.857.329	1.961			163,00	350,76	513,75	20	42	62	120.896	5,34	3,93	9,27	1,82E+04
9	BA	Feira de Santana	609.913	1.875	Percapita weight	Percapita weight	34,79	74,87	109,66	4	9	13	24.674	1,14	0,84	1,98	3,71E+03
10	BA	Vitória da Conquista	338.885	1.600	0,00005704460754	0,0001227566181	19,33	41,60	60,93	2	5	7	11.699	0,63	0,47	1,10	1,76E+03
11	BA	Camaçari	293.723	1.950	t/people/year	t/people/year	16,76	36,06	52,81	2	4	6	12.358	0,55	0,40	0,95	1,86E+03
12	BA	Juazeiro	215.183	2.201			12,28	26,42	38,69	1	3	5	10.219	0,40	0,30	0,70	1,54E+03
13	BA	Itabuna	212.740	1.815			12,14	26,12	38,25	1	3	5	8.331	0,40	0,29	0,69	1,25E+03
14	BA	Lauro de Freitas	195.095	1.956			11,13	23,95	35,08	1	3	4	8.234	0,36	0,27	0,63	1,24E+03
15	BA	Ilhéus	164.844	1.691			9,40	20,24	29,64	1	2	4	6.014	0,31	0,23	0,53	9,04E+02
16	BA	Teixeira de Freitas	158.445	1.286			9,04	19,45	28,49	1	2	3	4.396	0,30	0,22	0,51	6,61E+02
17	BA	Jequié	155.800	1.753			8,89	19,13	28,01	1	2	3	5.893	0,29	0,21	0,51	8,86E+02
18	BA	Barreiras	153.831	1.584			8,78	18,88	27,66	1	2	3	5.257	0,29	0,21	0,50	7,91E+02
19	BA	Alagoinhas	150.832	1.924			8,60	18,52	27,12	1	2	3	6.261	0,28	0,21	0,49	9,42E+02
20	BA	Porto Seguro	146.625	1.844			8,36	18,00	26,36	1	2	3	5.834	0,27	0,20	0,48	8,77E+02
21	BA	Simões Filho	132.906	1.937			7,58	16,32	23,90	1	2	3	5.555	0,25	0,18	0,43	8,35E+02
22	BA	Paulo Afonso	117.014	2.209			6,68	14,36	21,04	1	2	3	5.577	0,22	0,16	0,38	8,39E+02
23	CE	Fortaleza	2.643.247	2.904			150,78	324,48	475,26	18	39	57	165.618	4,94	3,64	8,58	2,49E+04
24	CE	Caucaia	363.982	3.081			20,76	44,68	65,44	2	5	8	24.196	0,68	0,50	1,18	3,64E+03
25	CE	Juazeiro do Norte	271.926	2.456			15,51	33,38	48,89	2	4	6	14.410	0,51	0,37	0,88	2,17E+03
26	CE	Maracanaú	226.128	3.090			12,90	27,76	40,66	2	3	5	15.076	0,42	0,31	0,73	2,27E+03
27	CE	Sobral	206.644	3.005			11,79	25,37	37,15	1	3	4	13.398	0,39	0,28	0,67	2,01E+03
28	CE	Crato	131.372	2.464			7,49	16,13	23,62	1	2	3	6.984	0,25	0,18	0,43	1,05E+03
29	CE	Itapipoca	128.135	3.103			7,31	15,73	23,04	1	2	3	8.579	0,24	0,18	0,42	1,29E+03
30	CE	Maranguape	127.098	3.073			7,25	15,60	22,85	1	2	3	8.427	0,24	0,17	0,41	1,27E+03
31	DF	Brasília	2.974.703	1.008			169,69	365,16	534,86	20	44	64	64.696	5,56	4,09	9,65	9,73E+03
32	ES	Serra	507.598	977			28,96	62,31	91,27	3	7	11	10.700	0,95	0,70	1,65	1,61E+03
33	ES	Vila Velha	486.208	945			27,74	59,69	87,42	3	7	10	9.914	0,91	0,67	1,58	1,49E+03
34	ES	Cariacica	378.603	948			21,60	46,48	68,07	3	6	8	7.744	0,71	0,52	1,23	1,16E+03
35	ES	Vitória	358.267	946			20,44	43,98	64,42	2	5	8	7.313	0,67	0,49	1,16	1,10E+03
36	ES	Cachoeiro de Itapemirim	207.324	828			11,83	25,45	37,28	1	3	4	3.704	0,39	0,29	0,67	5,57E+02
37	ES	Linhares	170.364	1.086			9,72	20,91	30,63	1	3	4	3.992	0,32	0,23	0,55	6,00E+02
38	ES	São Mateus	128.542	1.168			7,33	15,78	23,11	1	2	3	3.239	0,24	0,18	0,42	4,87E+02
39	ES	Guarapari	122.982	906			7,02	15,10	22,11	1	2	3	2.404	0,23	0,17	0,40	3,62E+02
40	GO	Goiânia	1.495.705	930			85,32	183,61	268,93	10	22	32	30.013	2,80	2,06	4,85	4,51E+03
41	GO	Aparecida de Goiânia	565.957	911			32,28	69,47	101,76	4	8	12	11.124	1,06	0,78	1,84	1,67E+03
42	GO	Anápolis	381.970	982			21,79	46,89	68,68	3	6	8	8.093	0,71	0,53	1,24	1,22E+03
43	GO	Rio Verde	229.651	927			13,10	28,19	41,29	2	3	5	4.593	0,43	0,32	0,75	6,91E+02
44	GO	Águas Lindas de Goiás	207.070	1.035			11,81	25,42	37,23	1	3	4	4.624	0,39	0,28	0,67	6,95E+02
45	GO	Luziânia	205.023	952			11,70	25,17	36,86	1	3	4	4.211	0,38	0,28	0,67	6,33E+02
46	GO	Valparaíso de Goiás	164.723	970			9,40	20,22	29,62	1	2	4	3.447	0,31	0,23	0,53	5,18E+02
47	GO	Trindade	125.328	953			7,15	15,38	22,53	1	2	3	2.577	0,23	0,17	0,41	3,88E+02
48	GO	Formosa	119.506	1.053			6,82	14,67	21,49	1	2	3	2.715	0,22	0,16	0,39	4,08E+02
49	GO	Novo Gama	113.679	979			6,48	13,95	20,44	1	2	2	2.401	0,21	0,16	0,37	3,61E+02
50	MA	São Luís	1.094.667	2.935			62,44	134,38	196,82	7	16	24	69.321	2,05	1,51	3,55	1,04E+04
51	MA	Imperatriz	258.016	2.330			14,72	31,67	46,39	2	4	6	12.971	0,48	0,35	0,84	1,95E+03
52	MA	São José de Ribamar	176.321	2.947			10,06	21,64	31,70	1	3	4	11.211	0,33	0,24	0,57	1,69E+03
53	MA	Timon	167.973	2.656			9,58	20,62	30,20	1	2	4	9.626	0,31	0,23	0,55	1,45E+03
54	MA	Caxias	164.224	2.676			9,37	20,16	29,53	1	2	4	9.482	0,31	0,23	0,53	1,43E+03
55	MA	Codó	122.597	2.774			6,99	15,05	22,04	1	2	3	7.338	0,23	0,17	0,40	1,10E+03
56	MG	Belo Horizonte	2.501.576	584			142,70	307,09	449,79	17	37	54	31.521	4,67	3,44	8,12	4,74E+03
57	MG	Uberlândia	683.247	587			38,98	83,87	122,85	5	10	15	8.653	1,28	0,94	2,22	1,30E+03
58	MG	Contagem	659.070	573			37,60	80,91	118,50	5	10	14	8.148	1,23	0,91	2,14	1,23E+03
59	MG	Juiz de Fora	564.310	508			32,19	69,27	101,46	4	8	12	6.185	1,05	0,78	1,83	9,30E+02
60	MG	Betim	432.575	590			24,68	53,10	77,78	3	6	9	5.507	0,81	0,60	1,40	8,28E+02
61	MG	Montes Claros	404.804	980			23,09	49,69	72,78	3	6	9	8.559	0,76	0,56	1,31	1,29E+03
62	MG	Ribeirão das Neves	331.045	598			18,88	40,64	59,52	2	5	7	4.271	0,62	0,46	1,07	6,42E+02
63	MG	Uberaba	330.361	482			18,85	40,55	59,40	2	5	7	3.436	0,62	0,45	1,07	5,17E+02
64	MG	Governador Valadares	278.685	894			15,90	34,21	50,11	2	4	6	5.376	0,52	0,38	0,90	8,08E+02
65	MG	Ipatinga	261.344	792			14,91	32,08	46,99	2	4	6	4.466	0,49	0,36	0,85	6,72E+02
66	MG	Sete Lagoas	237.286	634			13,54	29,13	42,66	2	3	5	3.246	0,44	0,33	0,77	4,88E+02
67	MG	Divinópolis	235.977	511			13,46	28,97	42,43	2	3	5	2.602	0,44	0,32	0,77	3,91E+02
68	MG	Santa Luzia	218.147	599			12,44	26,78	39,22	1	3	5	2.819	0,41	0,30	0,71	4,24E+02
69	MG	Ibirité	179.015	572			10,21	21,98	32,19	1	3	4	2.209	0,33	0,25	0,58	3,32E+02
70	MG	Poços de Caldas	166.111	258			9,48	20,39	29,87	1	2	4	925	0,31	0,23	0,54	1,39E+02
71	MG	Patos de Minas	150.833	721			8,60	18,52	27,12	1	2	3	2.346	0,28	0,21	0,49	3,53E+02
72	MG	Pouso Alegre	148.862	211			8,49	18,27	26,77	1	2	3	678	0,28	0,20	0,48	1,02E+02
73	MG	Teófilo Otoni	140.235	1.024			8,00	17,21	25,21	1	2	3	3.098	0,26	0,19	0,46	4,66E+02
74	MG	Barbacena	136.392	526			7,78	16,74	24,52	1	2	3	1.548	0,25	0,19	0,44	2,33E+02

75	MG	Sabará	135.421	605	7,73	16,62	24,35	1	2	3	1.768	0,25	0,19	0,44	2,66E+02
76	MG	Varginha	134.477	317	7,67	16,51	24,18	1	2	3	920	0,25	0,19	0,44	1,38E+02
77	MG	Conselheiro Lafaiete	127.539	592	7,28	15,66	22,93	1	2	3	1.629	0,24	0,18	0,41	2,45E+02
78	MG	Vespasiano	125.376	610	7,15	15,39	22,54	1	2	3	1.650	0,23	0,17	0,41	2,48E+02
79	MG	Itabira	119.186	687	6,80	14,63	21,43	1	2	3	1.767	0,22	0,16	0,39	2,66E+02
80	MG	Araguari	116.691	622	6,66	14,32	20,98	1	2	3	1.566	0,22	0,16	0,38	2,36E+02
81	MG	Ubá	114.265	585	6,52	14,03	20,54	1	2	2	1.442	0,21	0,16	0,37	2,17E+02
82	MG	Passos	113.998	385	6,50	13,99	20,50	1	2	2	947	0,21	0,16	0,37	1,42E+02
83	MG	Coronel Fabriciano	109.405	777	6,24	13,43	19,67	1	2	2	1.834	0,20	0,15	0,35	2,76E+02
84	MG	Muriaé	108.113	628	6,17	13,27	19,44	1	2	2	1.465	0,20	0,15	0,35	2,20E+02
85	MG	Araxá	105.083	568	5,99	12,90	18,89	1	2	2	1.288	0,20	0,14	0,34	1,94E+02
86	MG	Ituiutaba	104.067	691	5,94	12,77	18,71	1	2	2	1.552	0,19	0,14	0,34	2,33E+02
87	MG	Lavras	102.728	380	5,86	12,61	18,47	1	2	2	842	0,19	0,14	0,33	1,27E+02
88	MS	Campo Grande	885.711	987	50,53	108,73	159,25	6	13	19	18.862	1,66	1,22	2,87	2,84E+03
89	MS	Dourados	220.965	982	12,60	27,12	39,73	2	3	5	4.682	0,41	0,30	0,72	7,04E+02
90	MS	Três Lagoas	119.465	668	6,81	14,67	21,48	1	2	3	1.722	0,22	0,16	0,39	2,59E+02
91	MS	Corumbá	110.806	1.494	6,32	13,60	19,92	1	2	2	3.572	0,21	0,15	0,36	5,37E+02
92	MT	Cuiabá	607.153	1.529	34,63	74,53	109,17	4	9	13	20.030	1,13	0,84	1,97	3,01E+03
93	MT	Várzea Grande	282.009	1.535	16,09	34,62	50,71	2	4	6	9.340	0,53	0,39	0,92	1,40E+03
94	MT	Rondonópolis	228.857	1.313	13,06	28,09	41,15	2	3	5	6.483	0,43	0,31	0,74	9,75E+02
95	PA	Belém	1.485.732	2.895	84,75	182,38	267,14	10	22	32	92.803	2,78	2,04	4,82	1,40E+04
96	PA	Ananindeua	525.566	2.877	29,98	64,52	94,50	4	8	11	32.624	0,98	0,72	1,71	4,91E+03
97	PA	Santarém	302.667	3.295	17,27	37,15	54,42	2	4	7	21.518	0,57	0,42	0,98	3,24E+03
98	PA	Marabá	275.086	2.346	15,69	33,77	49,46	2	4	6	13.924	0,51	0,38	0,89	2,09E+03
99	PA	Parauapebas	202.882	2.423	11,57	24,91	36,48	1	3	4	10.606	0,38	0,28	0,66	1,60E+03
100	PA	Castanhal	198.294	2.837	11,31	24,34	35,65	1	3	4	12.138	0,37	0,27	0,64	1,83E+03
101	PA	Abaetetuba	156.292	2.787	8,92	19,19	28,10	1	2	3	9.398	0,29	0,22	0,51	1,41E+03
102	PB	João Pessoa	800.323	2.748	45,65	98,24	143,90	5	12	17	47.452	1,50	1,10	2,60	7,14E+03
103	PB	Campina Grande	407.472	2.647	23,24	50,02	73,26	3	6	9	23.272	0,76	0,56	1,32	3,50E+03
104	PB	Santa Rita	135.807	2.753	7,75	16,67	24,42	1	2	3	8.067	0,25	0,19	0,44	1,21E+03
105	PB	Patos	106.984	2.609	6,10	13,13	19,24	1	2	2	6.022	0,20	0,15	0,35	9,06E+02
106	PE	Recife	1.637.834	2.636	93,43	201,05	294,48	11	24	35	93.151	3,06	2,25	5,31	1,40E+04
107	PE	Jaboatão dos Guararapes	697.636	2.625	39,80	85,64	125,44	5	10	15	39.512	1,30	0,96	2,26	5,94E+03
108	PE	Olinda	391.835	2.645	22,35	48,10	70,45	3	6	8	22.362	0,73	0,54	1,27	3,36E+03
109	PE	Caruaru	356.872	2.535	20,36	43,81	64,17	2	5	8	19.519	0,67	0,49	1,16	2,94E+03
110	PE	Petrolina	343.865	2.206	19,62	42,21	61,83	2	5	7	16.367	0,64	0,47	1,12	2,46E+03
111	PE	Paulista	329.117	2.660	18,77	40,40	59,18	2	5	7	18.889	0,62	0,45	1,07	2,84E+03
112	PE	Cabo de Santo Agostinho	205.112	2.601	11,70	25,18	36,88	1	3	4	11.511	0,38	0,28	0,67	1,73E+03
113	PE	Camaragibe	156.736	2.641	8,94	19,24	28,18	1	2	3	8.931	0,29	0,22	0,51	1,34E+03
114	PE	Garanhuns	138.983	2.408	7,93	17,06	24,99	1	2	3	7.221	0,26	0,19	0,45	1,09E+03
115	PE	Vitória de Santo Antão	137.915	2.584	7,87	16,93	24,80	1	2	3	7.689	0,26	0,19	0,45	1,16E+03
116	PE	Igarassu	115.640	2.6661	6,60	14,20	20,79	1	2	2	4.338.802	0,22	0,16	0,38	6,52E+05
117	PE	São Lourenço da Mata	112.362	2.635	6,41	13,79	20,20	1	2	2	6.388	0,21	0,15	0,36	9,61E+02
118	PE	Santa Cruz do Capibaribe	105.936	2.560	6,04	13,00	19,05	1	2	2	5.851	0,20	0,15	0,34	8,80E+02
119	PE	Abreu e Lima	99.622	2.653	5,68	12,23	17,91	1	1	2	5.703	0,19	0,14	0,32	8,58E+02
120	PE	Ipojuca	94.709	2.602	5,40	11,63	17,03	1	1	2	5.317	0,18	0,13	0,31	8,00E+02
121	PI	Teresina	861.442	2.654	49,14	105,75	154,89	6	13	19	49.329	1,61	1,19	2,80	7,42E+03
122	PR	Curitiba	1.917.185	408	109,37	235,35	344,71	13	28	41	16.877	3,58	2,64	6,22	2,54E+03
123	PR	Londrina	563.943	537	32,17	69,23	101,40	4	8	12	6.534	1,05	0,78	1,83	9,83E+02
124	PR	Maringá	417.010	649	23,79	51,19	74,98	3	6	9	5.839	0,78	0,57	1,35	8,78E+02
125	PR	Ponta Grossa	348.043	516	19,85	42,72	62,58	2	5	8	3.875	0,65	0,48	1,13	5,83E+02
126	PR	Cascavel	324.476	929	18,51	39,83	58,34	2	5	7	6.504	0,61	0,45	1,05	9,78E+02
127	PR	São José dos Pinhais	317.476	409	18,11	38,97	57,08	2	5	7	2.802	0,59	0,44	1,03	4,21E+02
128	PR	Foz do Iguaçu	258.823	1.058	14,76	31,77	46,54	2	4	6	5.908	0,48	0,36	0,84	8,88E+02
129	PR	Colombo	240.840	394	13,74	29,56	43,30	2	4	5	2.047	0,45	0,33	0,78	3,08E+02
130	PR	Guarapuava	180.334	670	10,29	22,14	32,42	1	3	4	2.607	0,34	0,25	0,59	3,92E+02
131	PR	Paranaguá	153.666	435	8,77	18,86	27,63	1	2	3	1.442	0,29	0,21	0,50	2,17E+02
132	PR	Araucária	141.410	432	8,07	17,36	25,43	1	2	3	1.318	0,26	0,19	0,46	1,98E+02
133	PR	Toledo	138.572	926	7,90	17,01	24,92	1	2	3	2.769	0,26	0,19	0,45	4,16E+02
134	PR	Apucarana	133.726	588	7,63	16,42	24,04	1	2	3	1.697	0,25	0,18	0,43	2,55E+02
135	PR	Pinhais	130.789	402	7,46	16,06	23,52	1	2	3	1.134	0,24	0,18	0,42	1,71E+02
136	PR	Campo Largo	130.091	525	7,42	15,97	23,39	1	2	3	1.474	0,24	0,18	0,42	2,22E+02
137	PR	Arapongas	121.198	571	6,91	14,88	21,79	1	2	3	1.493	0,23	0,17	0,39	2,25E+02
138	PR	Almirante Tamandaré	117.168	413	6,68	14,38	21,07	1	2	3	1.044	0,22	0,16	0,38	1,57E+02
139	PR	Piraquara	111.052	466	6,33	13,63	19,97	1	2	2	1.117	0,21	0,15	0,36	1,68E+02
140	PR	Umuarama	110.590	810	6,31	13,58	19,88	1	2	2	1.933	0,21	0,15	0,36	2,91E+02
141	PR	Cambé	105.704	559	6,03	12,98	19,01	1	2	2	1.275	0,20	0,15	0,34	1,92E+02
142	PR	Fazenda Rio Grande	98.368	433	5,61	12,08	17,69	1	1	2	919	0,18	0,14	0,32	1,38E+02
143	RJ	Rio de Janeiro	6.688.927	444	381,57	821,11	1.202,68	46	99	144	64.079	12,50	9,20	21,70	9,64E+03
144	RJ	São Gonçalo	1.077.687	462	61,48	132,29	193,77	7	16	23	10.743	2,01	1,48	3,50	1,62E+03
145	RJ	Duque de Caxias	914.383	422	52,16	112,25	164,41	6	13	20	8.326	1,71	1,26	2,97	1,25E+03
146	RJ	Nova Iguaçu	818.875	408	46,71	100,52	147,23	6	12	18	7.209	1,53	1,13	2,66	1,08E+03
147	RJ	Niterói	511.786	449	29,19	62,83	92,02	4	8	11	4.958	0,96	0,70	1,66	7,46E+02
148	RJ	Belford Roxo	508.614	410	29,01	62,44	91,45	3	7	11	4.499	0,95	0,70	1,65	6,77E+02
149	RJ	Campos dos Goytacazes	503.424	709	28,72	61,80	90,52	3	7	11	7.701	0,94	0,69	1,63	1,16E+03
150	RJ	São João de Meriti	471.888	417	26,92	57,93	84,85	3	7	10	4.246	0,88	0,65	1,53	6,38E+02
151	RJ	Petrópolis	305.687	458	17,44	37,53	54,96	2	5	7	3.021	0,57	0,42	0,99	4,54E+02
152	RJ	Volta Redonda	271.998	327	15,52	33,39	48,91	2	4	6	1.919	0,51	0,37	0,88	2,89E+02
153	RJ	Macaé	251.631	618	14,35	30,89	45,24	2	4	5	3.355	0,47	0,35	0,82	5,05E+02

154	RJ	Magé	243.657	454	13,90	29,91	43,81	2	4	5	2.387	0,46	0,34	0,79	3,59E+02
155	RJ	Itaboraí	238.695	480	13,62	29,30	42,92	2	4	5	2.472	0,45	0,33	0,77	3,72E+02
156	RJ	Cabo Frio	222.528	583	12,69	27,32	40,01	2	3	5	2.799	0,42	0,31	0,72	4,21E+02
157	RJ	Angra dos Reis	200.407	405	11,43	24,60	36,03	1	3	4	1.751	0,37	0,28	0,65	2,63E+02
158	RJ	Nova Friburgo	190.084	546	10,84	23,33	34,18	1	3	4	2.239	0,36	0,26	0,62	3,37E+02
159	RJ	Barra Mansa	183.976	312	10,49	22,58	33,08	1	3	4	1.238	0,34	0,25	0,60	1,86E+02
160	RJ	Teresópolis	180.886	491	10,32	22,20	32,52	1	3	4	1.916	0,34	0,25	0,59	2,88E+02
161	RJ	Mesquita	175.620	409	10,02	21,56	31,58	1	3	4	1.550	0,33	0,24	0,57	2,33E+02
162	RJ	Nilópolis	162.269	416	9,26	19,92	29,18	1	2	4	1.456	0,30	0,22	0,53	2,19E+02
163	RJ	Maricá	157.789	489	9,00	19,37	28,37	1	2	3	1.665	0,29	0,22	0,51	2,50E+02
164	RJ	Queimados	149.265	395	8,51	18,32	26,84	1	2	3	1.272	0,28	0,21	0,48	1,91E+02
165	RJ	Rio das Ostras	145.989	597	8,33	17,92	26,25	1	2	3	1.880	0,27	0,20	0,47	2,83E+02
166	RJ	Araruama	130.439	547	7,44	16,01	23,45	1	2	3	1.539	0,24	0,18	0,42	2,32E+02
167	RJ	Resende	130.334	283	7,43	16,00	23,43	1	2	3	796	0,24	0,18	0,42	1,20E+02
168	RJ	Itaguaí	125.913	408	7,18	15,46	22,64	1	2	3	1.108	0,24	0,17	0,41	1,67E+02
169	RJ	Japeri	103.960	387	5,93	12,76	18,69	1	2	2	868	0,19	0,14	0,34	1,31E+02
170	RJ	São Pedro da Aldeia	102.846	571	5,87	12,63	18,49	1	2	2	1.267	0,19	0,14	0,33	1,91E+02
171	RN	Natal	877.640	3.075	50,06	107,74	157,80	6	13	19	58.228	1,64	1,21	2,85	8,76E+03
172	RN	Mossoró	294.076	2.766	16,78	36,10	52,88	2	4	6	17.550	0,55	0,40	0,95	2,64E+03
173	RN	Parnamirim	255.793	3.055	14,59	31,40	45,99	2	4	6	16.861	0,48	0,35	0,83	2,54E+03
174	RN	São Gonçalo do Amarante	101.102	3.079	5,77	12,41	18,18	1	1	2	6.717	0,19	0,14	0,33	1,01E+03
175	RO	Porto Velho	519.531	2.987	29,64	63,78	93,41	4	8	11	33.483	0,97	0,71	1,69	5,04E+03
176	RR	Boa Vista	375.374	4.657	21,41	46,08	67,49	3	6	8	37.718	0,70	0,52	1,22	5,67E+03
177	RS	Porto Alegre	1.479.101	1.130	84,37	181,57	265,94	10	22	32	36.062	2,76	2,04	4,80	5,42E+03
178	RS	Caxias do Sul	504.069	977	28,75	61,88	90,63	3	7	11	10.626	0,94	0,69	1,64	1,60E+03
179	RS	Canoas	344.957	1.128	19,68	42,35	62,02	2	5	7	8.396	0,64	0,47	1,12	1,26E+03
180	RS	Pelotas	341.648	1.380	19,49	41,94	61,43	2	5	7	10.173	0,64	0,47	1,11	1,53E+03
181	RS	Santa Maria	280.505	1.258	16,00	34,43	50,44	2	4	6	7.614	0,52	0,39	0,91	1,14E+03
182	RS	Gravataí	279.398	1.105	15,94	34,30	50,24	2	4	6	6.661	0,52	0,38	0,91	1,00E+03
183	RS	Viamão	254.101	1.128	14,50	31,19	45,69	2	4	5	6.184	0,47	0,35	0,82	9,30E+02
184	RS	Novo Hamburgo	246.452	1.143	14,06	30,25	44,31	2	4	5	6.078	0,46	0,34	0,80	9,14E+02
185	RS	São Leopoldo	234.947	1.134	13,40	28,84	42,24	2	3	5	5.749	0,44	0,32	0,76	8,64E+02
186	RS	Rio Grande	210.005	1.352	11,98	25,78	37,76	1	3	5	6.126	0,39	0,29	0,68	9,21E+02
187	RS	Alvorada	209.213	1.120	11,93	25,68	37,62	1	3	5	5.056	0,39	0,29	0,68	7,60E+02
188	RS	Passo Fundo	201.767	957	11,51	24,77	36,28	1	3	4	4.166	0,38	0,28	0,65	6,27E+02
189	RS	Sapucaia do Sul	140.311	1.124	8,00	17,22	25,23	1	2	3	3.403	0,26	0,19	0,46	5,12E+02
190	RS	Santa Cruz do Sul	129.427	1.271	7,38	15,89	23,27	1	2	3	3.549	0,24	0,18	0,42	5,34E+02
191	RS	Cachoeirinha	129.307	1.113	7,38	15,87	23,25	1	2	3	3.105	0,24	0,18	0,42	4,67E+02
192	RS	Uruguaiana	127.079	1.570	7,25	15,60	22,85	1	2	3	4.305	0,24	0,17	0,41	6,47E+02
193	RS	Bagé	120.943	1.496	6,90	14,85	21,75	1	2	3	3.904	0,23	0,17	0,39	5,87E+02
194	RS	Bento Gonçalves	119.049	1.017	6,79	14,61	21,41	1	2	3	2.612	0,22	0,16	0,39	3,93E+02
195	RS	Erechim	105.059	877	5,99	12,90	18,89	1	2	2	1.988	0,20	0,14	0,34	2,99E+02
196	SC	Joinville	583.144	583	33,27	71,58	104,85	4	9	13	7.335	1,09	0,80	1,89	1,10E+03
197	SC	Florianópolis	492.977	758	28,12	60,52	88,64	3	7	11	8.063	0,92	0,68	1,60	1,21E+03
198	SC	Blumenau	352.460	637	20,11	43,27	63,37	2	5	8	4.844	0,66	0,48	1,14	7,28E+02
199	SC	São José	242.927	746	13,86	29,82	43,68	2	4	5	3.910	0,45	0,33	0,79	5,88E+02
200	SC	Chapecó	216.654	879	12,36	26,60	38,95	1	3	5	4.109	0,40	0,30	0,70	6,18E+02
201	SC	Itajaí	215.895	662	12,32	26,50	38,82	1	3	5	3.084	0,40	0,30	0,70	4,64E+02
202	SC	Criciúma	213.023	938	12,15	26,15	38,30	1	3	5	4.311	0,40	0,29	0,69	6,48E+02
203	SC	Jaraguá do Sul	174.158	571	9,93	21,38	31,31	1	3	4	2.146	0,33	0,24	0,57	3,23E+02
204	SC	Palhoça	168.259	755	9,60	20,65	30,25	1	2	4	2.741	0,31	0,23	0,55	4,12E+02
205	SC	Lages	157.743	765	9,00	19,36	28,36	1	2	3	2.604	0,29	0,22	0,51	3,92E+02
206	SC	Balneário Camboriú	138.732	675	7,91	17,03	24,94	1	2	3	2.020	0,26	0,19	0,45	3,04E+02
207	SC	Brusque	131.703	694	7,51	16,17	23,68	1	2	3	1.972	0,25	0,18	0,43	2,97E+02
208	SC	Tubarão	104.937	874	5,99	12,88	18,87	1	2	2	1.979	0,20	0,14	0,34	2,98E+02
209	SC	São Bento do Sul	83.576	511	4,77	10,26	15,03	1	1	2	921	0,16	0,11	0,27	1,39E+02
210	SE	Aracaju	648.939	2.155	37,02	79,66	116,68	4	10	14	30.173	1,21	0,89	2,11	4,54E+03
211	SE	Nossa Senhora do Socorro	181.503	2.153	10,35	22,28	32,63	1	3	4	8.431	0,34	0,25	0,59	1,27E+03
212	SE	Lagarto	103.576	2.119	5,91	12,71	18,62	1	2	2	4.735	0,19	0,14	0,34	7,12E+02
213	SP	São Paulo	12.176.866		694,62	1494,79	2.189,42	83	179	263	0	22,76	16,75	39,51	0,00E+00
214	SP	Guarulhos	1.365.899	20	77,92	167,67	245,59	9	20	29	589	2,55	1,88	4,43	8,86E+01
215	SP	Campinas	1.194.094	99	68,12	146,58	214,70	8	18	26	2.551	2,23	1,64	3,87	3,84E+02
216	SP	São Bernardo do Campo	833.240	22,7	47,53	102,29	149,82	6	12	18	408	1,56	1,15	2,70	6,14E+01
217	SP	Santo André	716.109	23,7	40,85	87,91	128,76	5	11	15	366	1,34	0,99	2,32	5,51E+01
218	SP	São José dos Campos	713.943	97,4	40,73	87,64	128,37	5	11	15	1.500	1,33	0,98	2,32	2,26E+02
219	SP	Osasco	696.850	23,4	39,75	85,54	125,29	5	10	15	352	1,30	0,96	2,26	5,29E+01
220	SP	Ribeirão Preto	694.534	316	39,62	85,26	124,88	5	10	15	4.735	1,30	0,96	2,25	7,12E+02
221	SP	Sorocaba	671.186	104	38,29	82,39	120,68	5	10	14	1.506	1,25	0,92	2,18	2,26E+02
222	SP	Mauá	468.148	27,1	26,71	57,47	84,17	3	7	10	274	0,87	0,64	1,52	4,12E+01
223	SP	São José do Rio Preto	456.245	440	26,03	56,01	82,03	3	7	10	4.331	0,85	0,63	1,48	6,51E+02
224	SP	Mogi das Cruzes	440.769	63,7	25,14	54,11	79,25	3	6	10	606	0,82	0,61	1,43	9,11E+01
225	SP	Santos	432.957	81,2	24,70	53,15	77,85	3	6	9	759	0,81	0,60	1,40	1,14E+02
226	SP	Diadema	420.934	22,6	24,01	51,67	75,68	3	6	9	205	0,79	0,58	1,37	3,09E+01
227	SP	Jundiaí	414.810	58,8	23,66	50,92	74,58	3	6	9	526	0,78	0,57	1,35	7,91E+01
228	SP	Piracicaba	400.949	157	22,87	49,22	72,09	3	6	9	1.358	0,75	0,55	1,30	2,04E+02
229	SP	Carapicuíba	398.611	30	22,74	48,93	71,67	3	6	9	258	0,74	0,55	1,29	3,88E+01
230	SP	Bauru	374.272	332	21,35	45,94	67,29	3	6	8	2.681	0,70	0,51	1,21	4,03E+02
231	SP	Itaquaquecetuba	366.519	43,5	20,91	44,99	65,90	3	5	8	344	0,68	0,50	1,19	5,17E+01
232	SP	São Vicente	363.173	73	20,72	44,58	65,30	2	5	8	572	0,68	0,50	1,18	8,60E+01

233	SP	Franca	350.400	400	19,99	43,01	63,00	2	5	8	3.024	0,65	0,48	1,14	4,55E+02
234	SP	Praia Grande	319.146	77,6	18,21	39,18	57,38	2	5	7	534	0,60	0,44	1,04	8,04E+01
235	SP	Guarujá	318.107	98,9	18,15	39,05	57,20	2	5	7	679	0,59	0,44	1,03	1,02E+02
236	SP	Taubaté	311.854	140	17,79	38,28	56,07	2	5	7	942	0,58	0,43	1,01	1,42E+02
237	SP	Limeira	303.682	163	17,32	37,28	54,60	2	4	7	1.068	0,57	0,42	0,99	1,61E+02
238	SP	Suzano	294.638	51,7	16,81	36,17	52,98	2	4	6	329	0,55	0,41	0,96	4,94E+01
239	SP	Taboão da Serra	285.570	18,9	16,29	35,06	51,35	2	4	6	116	0,53	0,39	0,93	1,75E+01
240	SP	Sumaré	278.571	119	15,89	34,20	50,09	2	4	6	715	0,52	0,38	0,90	1,08E+02
241	SP	Barueri	271.306	31,7	15,48	33,30	48,78	2	4	6	186	0,51	0,37	0,88	2,79E+01
242	SP	Embu das Artes	270.843	31,1	15,45	33,25	48,70	2	4	6	182	0,51	0,37	0,88	2,73E+01
243	SP	São Carlos	249.415	234	14,23	30,62	44,85	2	4	5	1.259	0,47	0,34	0,81	1,89E+02
244	SP	Indaiatuba	246.908	103	14,08	30,31	44,39	2	4	5	549	0,46	0,34	0,80	8,25E+01
245	SP	Cotia	244.694	34	13,96	30,04	44,00	2	4	5	180	0,46	0,34	0,79	2,70E+01
246	SP	Marília	237.130	437	13,53	29,11	42,64	2	3	5	2.236	0,44	0,33	0,77	3,36E+02
247	SP	Americana	237.112	129	13,53	29,11	42,63	2	3	5	660	0,44	0,33	0,77	9,92E+01
248	SP	Itapevi	234.352	42,6	13,37	28,77	42,14	2	3	5	215	0,44	0,32	0,76	3,24E+01
249	SP	Araraquara	233.744	277	13,33	28,69	42,03	2	3	5	1.397	0,44	0,32	0,76	2,10E+02
250	SP	Jacareí	231.863	89,9	13,23	28,46	41,69	2	3	5	450	0,43	0,32	0,75	6,76E+01
251	SP	Hortolândia	227.353	115	12,97	27,91	40,88	2	3	5	564	0,42	0,31	0,74	8,48E+01
252	SP	Presidente Prudente	227.072	558	12,95	27,87	40,83	2	3	5	2.734	0,42	0,31	0,74	4,11E+02
253	SP	Rio Claro	204.797	188	11,68	25,14	36,82	1	3	4	831	0,38	0,28	0,66	1,25E+02
254	SP	Araçatuba	195.874	522	11,17	24,04	35,22	1	3	4	2.206	0,37	0,27	0,64	3,32E+02
255	SP	Santa Bárbara d'Oeste	192.536	139	10,98	23,64	34,62	1	3	4	577	0,36	0,26	0,62	8,68E+01
256	SP	Ferraz de Vasconcelos	191.993	32	10,95	23,57	34,52	1	3	4	133	0,36	0,26	0,62	1,99E+01
257	SP	Francisco Morato	174.008	47,7	9,93	21,36	31,29	1	3	4	179	0,33	0,24	0,56	2,69E+01
258	SP	Itapecerica da Serra	173.672	36,7	9,91	21,32	31,23	1	3	4	138	0,32	0,24	0,56	2,07E+01
259	SP	Itu	172.268	103	9,83	21,15	30,97	1	3	4	383	0,32	0,24	0,56	5,76E+01
260	SP	Bragança Paulista	166.753	87,5	9,51	20,47	29,98	1	2	4	315	0,31	0,23	0,54	4,73E+01
261	SP	Pindamonhangaba	166.475	157	9,50	20,44	29,93	1	2	4	564	0,31	0,23	0,54	8,48E+01
262	SP	Itapetininga	162.231	180	9,25	19,91	29,17	1	2	4	630	0,30	0,22	0,53	9,47E+01
263	SP	São Caetano do Sul	160.275	12,7	9,14	19,67	28,82	1	2	3	44	0,30	0,22	0,52	6,60E+00
264	SP	Franco da Rocha	152.433	43,3	8,70	18,71	27,41	1	2	3	142	0,28	0,21	0,49	2,14E+01
265	SP	Mogi Guaçu	150.713	162	8,60	18,50	27,10	1	2	3	527	0,28	0,21	0,49	7,92E+01
266	SP	Jaú	148.581	299	8,48	18,24	26,72	1	2	3	959	0,28	0,20	0,48	1,44E+02
267	SP	Botucatu	144.820	238	8,26	17,78	26,04	1	2	3	744	0,27	0,20	0,47	1,12E+02
268	SP	Atibaia	141.398	67,7	8,07	17,36	25,42	1	2	3	207	0,26	0,19	0,46	3,11E+01
269	SP	Santana de Parnaíba	136.517	41,5	7,79	16,76	24,55	1	2	3	122	0,26	0,19	0,44	1,84E+01
270	SP	Araras	132.934	172	7,58	16,32	23,90	1	2	3	493	0,25	0,18	0,43	7,42E+01
271	SP	Cubatão	129.760	70,7	7,40	15,93	23,33	1	2	3	198	0,24	0,18	0,42	2,98E+01
272	SP	Valinhos	127.123	91,8	7,25	15,61	22,86	1	2	3	252	0,24	0,17	0,41	3,79E+01
273	SP	Sertãozinho	124.453	336	7,10	15,28	22,38	1	2	3	902	0,23	0,17	0,40	1,36E+02
274	SP	Jandira	123.481	38	7,04	15,16	22,20	1	2	3	101	0,23	0,17	0,40	1,52E+01
275	SP	Ribeirão Pires	122.607	49,5	6,99	15,05	22,04	1	2	3	131	0,23	0,17	0,40	1,97E+01
276	SP	Birigui	122.359	514	6,98	15,02	22,00	1	2	3	1.357	0,23	0,17	0,40	2,04E+02
277	SP	Barretos	121.344	423	6,92	14,90	21,82	1	2	3	1.107	0,23	0,17	0,39	1,67E+02
278	SP	Votorantim	121.331	105	6,92	14,89	21,82	1	2	3	275	0,23	0,17	0,39	4,13E+01
279	SP	Catanduva	121.210	386	6,91	14,88	21,79	1	2	3	1.009	0,23	0,17	0,39	1,52E+02
280	SP	Guaratinguetá	121.073	188	6,91	14,86	21,77	1	2	3	491	0,23	0,17	0,39	7,39E+01
281	SP	Várzea Paulista	120.572	59,4	6,88	14,80	21,68	1	2	3	155	0,23	0,17	0,39	2,32E+01
282	SP	Tatuí	120.533	143	6,88	14,80	21,67	1	2	3	372	0,23	0,17	0,39	5,59E+01
283	SP	Caraguatatuba	119.625	181	6,82	14,68	21,51	1	2	3	467	0,22	0,16	0,39	7,03E+01
284	SP	Itatiba	119.090	83,6	6,79	14,62	21,41	1	2	3	215	0,22	0,16	0,39	3,23E+01
285	SP	Salto	117.561	103	6,71	14,43	21,14	1	2	3	261	0,22	0,16	0,38	3,93E+01
286	SP	Poá	116.530	47,7	6,65	14,30	20,95	1	2	3	120	0,22	0,16	0,38	1,80E+01
287	SP	Ourinhos	112.711	373	6,43	13,84	20,27	1	2	2	907	0,21	0,16	0,37	1,36E+02
288	SP	Paulínia	106.776	122	6,09	13,11	19,20	1	2	2	281	0,20	0,15	0,35	4,23E+01
289	SP	Assis	103.666	438	5,91	12,73	18,64	1	2	2	980	0,19	0,14	0,34	1,47E+02
290	SP	Leme	102.412	189	5,84	12,57	18,41	1	2	2	418	0,19	0,14	0,33	6,28E+01
291	SP	Itanhaém	100.496	115	5,73	12,34	18,07	1	1	2	249	0,19	0,14	0,33	3,75E+01
292	SP	Caieiras	100.129	36,7	5,71	12,29	18,00	1	1	2	79	0,19	0,14	0,32	1,19E+01
293	SP	Mairiporã	98.374	38	5,61	12,08	17,69	1	1	2	81	0,18	0,14	0,32	1,21E+01
294	TO	Palmas	291.855	1.814	16,65	35,83	52,48	2	4	6	11.423	0,55	0,40	0,95	1,72E+03
			116.067.062		6.621,00	14248,00	20.869,00	795	1.710	2.504	6.945.403,71	216,90	466,76	683,67	1,90E+06

Total of 400 municipalities included in RL					Smartphones waste generation	Laptops waste generation				Target RL - smartphones	Target RL - laptops		RL-WEEE				RL-LIBs
Nº	**State**	**City**	**Population**	**Distance to São Paulo city and state (km)**	**Unit (2025)**	**Unit (2025)**	**PERCAPITA WEIGHT-SMARTPHONES BY CITY**	**PERCAPITA WEIGHT-LAPTOPS BY CITY**	**Total weight**	**17%**	**17%**	**Total weight WEEE 2025**	**tkm/year/city WEEE**	**Allocation tkm/year for LIBs (% weight of smartphones 27,3%)**	**Allocation tkm/year for LIBs (% weight of laptops (9,34%)**	**Total LIBs weight**	**tkm/year/city for LIBs**
1	AC	Rio Branco	401.155	3.500	42.622.281	5.509.594	20,92	47,44	68,36	4	8	12	40.675	1	0,75	1,72	6.034,72
2	AC	Cruzeiro do Sul	87.673	4.130			4,57	10,37	14,94	1	2	3	10.490	0	0,16	0,38	1.556,30
3	AL	Maceió	1.012.382	2.408	Mass (t)	Mass (t)	52,80	119,73	172,52	9	20	29	70.624	2	1,90	4,35	10.477,98
4	AL	Arapiraca	230.417	2.306	6.587	14.937	12,02	27,25	39,27	2	5	7	15.393	1	0,43	0,99	2.283,76
5	AM	Manaus	2.145.444	3.876			111,89	253,72	365,61	19	43	62	240.908	5	4,03	9,22	35.741,90
6	AM	Parintins	113.168	2.560	Percapita unit	Percapita unit	5,90	13,38	19,29	1	2	3	8.393	0	0,21	0,49	1.245,20
7	AM	Itacoatiara	99.955	4.143	0,3374548175	0,0436212937	5,21	11,82	17,03	1	2	3	11.997	0	0,19	0,43	1.779,90
8	AM	Manacapuru	96.236	3.975			5,02	11,38	16,40	1	2	3	11.082	0	0,18	0,41	1.644,19
9	AM	Coari	84.272	2.795	Percapita weight	Percapita weight	4,39	9,97	14,36	1	2	2	6.824	0	0,16	0,36	1.012,38
10	AP	Macapá	493.634	3.404	0,00005215147642	0,000118261212	25,74	58,38	84,12	4	10	14	48.679	1	0,93	2,12	7.222,23
11	AP	Santana	119.610	3.423	t/people/year	t/people/year	6,24	14,15	20,38	1	2	3	11.861	0	0,22	0,51	1.759,75
12	BA	Salvador	2.857.329	1.961			149,01	337,91	486,93	25	57	83	162.326	7	5,37	12,28	24.083,22
13	BA	Feira de Santana	609.913	1.875			31,81	72,13	103,94	5	12	18	33.130	1	1,15	2,62	4.915,25
14	BA	Vitória da Conquista	338.885	1.600			17,67	40,08	57,75	3	7	10	15.708	1	0,64	1,46	2.330,50
15	BA	Camaçari	293.723	1.950			15,32	34,74	50,05	3	6	9	16.593	1	0,55	1,26	2.461,78
16	BA	Juazeiro	215.183	2.201			11,22	25,45	36,67	2	4	6	13.721	1	0,40	0,92	2.035,66
17	BA	Itabuna	212.740	1.815			11,09	25,16	36,25	2	4	6	11.186	1	0,40	0,91	1.659,60
18	BA	Lauro de Freitas	195.095	1.956			10,17	23,07	33,25	2	4	6	11.055	0	0,37	0,84	1.640,18
19	BA	Ilhéus	164.844	1.691			8,60	19,49	28,09	1	3	5	8.075	0	0,31	0,71	1.198,10
20	BA	Teixeira de Freitas	158.445	1.286			8,26	18,74	27,00	1	3	5	5.903	0	0,30	0,68	875,78
21	BA	Jequié	155.800	1.753			8,13	18,43	26,55	1	3	5	7.912	0	0,29	0,67	1.173,89
22	BA	Barreiras	153.831	1.584			8,02	18,19	26,21	1	3	4	7.059	0	0,29	0,66	1.047,31
23	BA	Alagoinhas	150.832	1.924			7,87	17,84	25,70	1	3	4	8.407	0	0,28	0,65	1.247,31
24	BA	Porto Seguro	146.625	1.844			7,65	17,34	24,99	1	3	4	7.833	0	0,28	0,63	1.162,11
25	BA	Simões Filho	132.906	1.937			6,93	15,72	22,65	1	3	4	7.458	0	0,25	0,57	1.106,50
26	BA	Paulo Afonso	117.014	2.209			6,10	13,84	19,94	1	2	3	7.488	0	0,22	0,50	1.110,99
27	BA	Eunápolis	112.318	1.781			5,86	13,28	19,14	1	2	3	5.795	0	0,21	0,48	859,79
28	BA	Santo Antônio de Jesus	100.605	1.782			5,25	11,90	17,14	1	2	3	5.194	0	0,19	0,43	770,56
29	BA	Valença	95.858	1.801			5,00	11,34	16,34	1	2	3	5.001	0	0,18	0,41	742,03
30	BA	Candeias	86.677	1.916			4,52	10,25	14,77	1	2	3	4.811	0	0,16	0,37	713,80
31	BA	Luís Eduardo Magalhães	84.753	1.517			4,42	10,02	14,44	1	2	2	3.725	0	0,16	0,36	552,61
32	BA	Guanambi	84.014	1.347			4,38	9,94	14,32	1	2	2	3.278	0	0,16	0,36	486,40
33	BA	Serrinha	80.411	1.911			4,19	9,51	13,70	1	2	2	4.452	0	0,15	0,35	660,47
34	BA	Jacobina	80.394	1.977			4,19	9,51	13,70	1	2	2	4.604	0	0,15	0,35	683,14
35	CE	Fortaleza	2.643.247	2.904			137,85	312,59	450,44	23	53	77	222.375	6	4,96	11,36	32.992,18
36	CE	Caucaia	363.982	3.081			18,98	43,04	62,03	3	7	11	32.488	1	0,68	1,56	4.820,01
37	CE	Juazeiro do Norte	271.926	2.456			14,18	32,16	46,34	2	5	8	19.348	1	0,51	1,17	2.870,49
38	CE	Maracanaú	226.128	3.090			11,79	26,74	38,54	2	5	7	20.242	1	0,42	0,97	3.003,24
39	CE	Sobral	206.644	3.005			10,78	24,44	35,21	2	4	6	17.989	1	0,39	0,89	2.668,97
40	CE	Crato	131.372	2.464			6,85	15,54	22,39	1	3	4	9.378	0	0,25	0,56	1.391,30
41	CE	Itapipoca	128.135	3.103			6,68	15,15	21,84	1	3	4	11.519	0	0,24	0,55	1.708,94
42	CE	Maranguape	127.098	3.073			6,63	15,03	21,66	1	3	4	11.315	0	0,24	0,55	1.678,72
43	CE	Iguatu	103.255	2.842			5,38	12,21	17,60	1	2	3	8.501	0	0,19	0,44	1.261,28
44	CE	Quixadá	87.116	2.974			4,54	10,30	14,85	1	2	3	7.506	0	0,16	0,37	1.113,56
45	CE	Pacatuba	83.157	3.082			4,34	9,83	14,17	1	2	2	7.425	0	0,16	0,36	1.101,56
46	DF	Brasília	2.974.703	1.008			155,14	351,79	506,93	26	60	86	86.867	7	5,59	12,79	12.887,86
47	ES	Serra	507.598	977			26,47	60,03	86,50	5	10	15	14.367	1	0,95	2,18	2.131,53
48	ES	Vila Velha	486.208	945			25,36	57,50	82,86	4	10	14	13.311	1	0,91	2,09	1.974,83
49	ES	Cariacica	378.603	948			19,74	44,77	64,52	3	8	11	10.398	1	0,71	1,63	1.542,66
50	ES	Vitória	358.267	946			18,68	42,37	61,05	3	7	10	9.819	1	0,67	1,54	1.456,72
51	ES	Cachoeiro de Itapemirim	207.324	828			10,81	24,52	35,33	2	4	6	4.973	1	0,39	0,89	737,83
52	ES	Linhares	170.364	1.086			8,88	20,15	29,03	2	3	5	5.360	0	0,32	0,73	795,21
53	ES	São Mateus	128.542	1.168			6,70	15,20	21,91	1	3	4	4.349	0	0,24	0,55	645,30
54	ES	Guarapari	122.982	906			6,41	14,54	20,96	1	2	4	3.228	0	0,23	0,53	478,90
55	ES	Colatina	121.580	1.084			6,34	14,38	20,72	1	2	4	3.818	0	0,23	0,52	566,46
56	ES	Aracruz	99.305	1.035			5,18	11,74	16,92	1	2	3	2.978	0	0,19	0,43	441,76
57	GO	Goiânia	1.495.705	930			78,00	176,88	254,89	13	30	43	40.298	4	2,81	6,43	5.978,68
58	GO	Aparecida de Goiânia	565.957	911			29,52	66,93	96,45	5	11	16	14.937	1	1,06	2,43	2.216,04
59	GO	Anápolis	381.970	982			19,92	45,17	65,09	3	8	11	10.867	1	0,72	1,64	1.612,19
60	GO	Rio Verde	229.651	927			11,98	27,16	39,14	2	5	7	6.167	1	0,43	0,99	915,01
61	GO	Águas Lindas de Goiás	207.070	1.035			10,80	24,49	35,29	2	4	6	6.209	1	0,39	0,89	921,16
62	GO	Luziânia	205.023	952			10,69	24,25	34,94	2	4	6	5.654	0	0,38	0,88	838,91
63	GO	Valparaíso de Goiás	164.723	970			8,59	19,48	28,07	1	3	5	4.629	0	0,31	0,71	686,76
64	GO	Trindade	125.328	953			6,54	14,82	21,36	1	3	4	3.460	0	0,24	0,54	513,35
65	GO	Formosa	119.506	1.053			6,23	14,13	20,37	1	2	3	3.646	0	0,22	0,51	540,87
66	GO	Novo Gama	113.679	979			5,93	13,44	19,37	1	2	3	3.224	0	0,21	0,49	478,34
67	GO	Senador Canedo	112.224	917			5,85	13,27	19,12	1	2	3	2.981	0	0,21	0,48	442,32
68	GO	Catalão	106.618	694			5,56	12,61	18,17	1	2	3	2.144	0	0,20	0,46	318,03
69	GO	Itumbiara	103.652	725			5,41	12,26	17,66	1	2	3	2.177	0	0,19	0,45	322,99
70	GO	Jataí	99.674	978			5,20	11,79	16,99	1	2	3	2.824	0	0,19	0,43	418,98
71	GO	Planaltina	89.181	1.041			4,65	10,55	15,20	1	2	3	2.690	0	0,17	0,38	399,02
72	GO	Caldas Novas	89.087	758			4,65	10,54	15,18	1	2	3	1.956	0	0,17	0,38	290,24
73	MA	São Luís	1.094.667	2.935			57,09	129,46	186,55	10	22	32	93.077	3	2,06	4,70	13.809,15
74	MA	Imperatriz	258.016	2.330			13,46	30,51	43,97	2	5	7	17.416	1	0,48	1,11	2.583,92
75	MA	São José de Ribamar	176.321	2.947			9,20	20,85	30,05	2	4	5	15.053	0	0,33	0,76	2.233,37
76	MA	Timon	167.973	2.656			8,76	19,86	28,62	1	3	5	12.925	0	0,32	0,72	1.917,54

77	MA	Caxias	164.224	2.676	8,56	19,42	27,99	1	3	5	12.731	0	0,31	0,71	1.888,86
78	MA	Codó	122.597	2.774	6,39	14,50	20,89	1	2	4	9.852	0	0,23	0,53	1.461,72
79	MA	Paço do Lumiar	120.621	2.939	6,29	14,26	20,56	1	2	3	10.270	0	0,23	0,52	1.523,70
80	MA	Açailândia	111.757	2.382	5,83	13,22	19,04	1	2	3	7.712	0	0,21	0,48	1.144,18
81	MA	Bacabal	104.633	2.693	5,46	12,37	17,83	1	2	3	8.163	0	0,20	0,45	1.211,10
82	MA	Balsas	93.826	2.262	4,89	11,10	15,99	1	2	3	6.148	0	0,18	0,40	912,21
83	MA	Santa Inês	88.590	2.699	4,62	10,48	15,10	1	2	3	6.927	0	0,17	0,38	1.027,70
84	MA	Barra do Corda	87.794	2.489	4,58	10,38	14,96	1	2	3	6.331	0	0,16	0,38	939,22
85	MA	Pinheiro	82.990	2.875	4,33	9,81	14,14	1	2	2	6.912	0	0,16	0,36	1.025,51
86	MG	Belo Horizonte	2.501.576	584	130,46	295,84	426,30	22	50	72	42.323	6	4,70	10,75	6.279,18
87	MG	Uberlândia	683.247	587	35,63	80,80	116,43	6	14	20	11.619	2	1,28	2,94	1.723,82
88	MG	Contagem	659.070	573	34,37	77,94	112,31	6	13	19	10.940	2	1,24	2,83	1.623,17
89	MG	Juiz de Fora	564.310	508	29,43	66,74	96,17	5	11	16	8.305	1	1,06	2,43	1.232,13
90	MG	Betim	432.575	590	22,56	51,16	73,72	4	9	13	7.394	1	0,81	1,86	1.096,96
91	MG	Montes Claros	404.804	980	21,11	47,87	68,98	4	8	12	11.493	1	0,76	1,74	1.705,09
92	MG	Ribeirão das Neves	331.045	598	17,26	39,15	56,41	3	7	10	5.735	1	0,62	1,42	850,87
93	MG	Uberaba	330.361	482	17,23	39,07	56,30	3	7	10	4.613	1	0,62	1,42	684,40
94	MG	Governador Valadares	278.685	894	14,53	32,96	47,49	2	6	8	7.218	1	0,52	1,20	1.070,85
95	MG	Ipatinga	261.344	792	13,63	30,91	44,54	2	5	8	5.996	1	0,49	1,12	889,64
96	MG	Sete Lagoas	237.286	634	12,37	28,06	40,44	2	5	7	4.358	1	0,45	1,02	646,60
97	MG	Divinópolis	235.977	511	12,31	27,91	40,21	2	5	7	3.493	1	0,44	1,01	518,28
98	MG	Santa Luzia	218.147	599	11,38	25,80	37,18	2	4	6	3.786	1	0,41	0,94	561,63
99	MG	Ibirité	179.015	572	9,34	21,17	30,51	2	4	5	2.966	0	0,34	0,77	440,11
100	MG	Poços de Caldas	166.111	258	8,66	19,64	28,31	1	3	5	1.242	0	0,31	0,71	184,20
101	MG	Patos de Minas	150.833	721	7,87	17,84	25,70	1	3	4	3.151	0	0,28	0,65	467,42
102	MG	Pouso Alegre	148.862	211	7,76	17,60	25,37	1	3	4	910	0	0,28	0,64	135,00
103	MG	Teófilo Otoni	140.235	1.024	7,31	16,58	23,90	1	3	4	4.160	0	0,26	0,60	617,21
104	MG	Barbacena	136.392	526	7,11	16,13	23,24	1	3	4	2.078	0	0,26	0,59	308,36
105	MG	Sabará	135.421	605	7,06	16,02	23,08	1	3	4	2.374	0	0,25	0,58	352,14
106	MG	Varginha	134.477	317	7,01	15,90	22,92	1	3	4	1.235	0	0,25	0,58	183,22
107	MG	Conselheiro Lafaiete	127.539	592	6,65	15,08	21,73	1	3	4	2.187	0	0,24	0,55	324,52
108	MG	Vespasiano	125.376	610	6,54	14,83	21,37	1	3	4	2.216	0	0,24	0,54	328,72
109	MG	Itabira	119.186	687	6,22	14,10	20,31	1	2	3	2.372	0	0,22	0,51	351,93
110	MG	Araguari	116.691	622	6,09	13,80	19,89	1	2	3	2.103	0	0,22	0,50	311,96
111	MG	Ubá	114.265	585	5,96	13,51	19,47	1	2	3	1.937	0	0,21	0,49	287,31
112	MG	Passos	113.998	385	5,95	13,48	19,43	1	2	3	1.271	0	0,21	0,49	188,64
113	MG	Coronel Fabriciano	109.405	777	5,71	12,94	18,64	1	2	3	2.463	0	0,21	0,47	365,37
114	MG	Muriaé	108.113	628	5,64	12,79	18,42	1	2	3	1.967	0	0,20	0,46	291,82
115	MG	Araxá	105.083	568	5,48	12,43	17,91	1	2	3	1.729	0	0,20	0,45	256,54
116	MG	Ituiutaba	104.067	691	5,43	12,31	17,73	1	2	3	2.083	0	0,20	0,45	309,08
117	MG	Lavras	102.728	380	5,36	12,15	17,51	1	2	3	1.131	0	0,19	0,44	167,78
118	MG	Nova Serrana	99.770	552	5,20	11,80	17,00	1	2	3	1.595	0	0,19	0,43	236,71
119	MG	Itajubá	96.389	261	5,03	11,40	16,43	1	2	3	729	0	0,18	0,41	108,13
120	MG	Nova Lima	93.577	603	4,88	11,07	15,95	1	2	3	1.635	0	0,18	0,40	242,53
121	MG	Pará de Minas	93.101	572	4,86	11,01	15,87	1	2	3	1.543	0	0,17	0,40	228,89
122	MG	Itaúna	92.561	544	4,83	10,95	15,77	1	2	3	1.459	0	0,17	0,40	216,42
123	MG	Paracatu	92.430	860	4,82	10,93	15,75	1	2	3	2.303	0	0,17	0,40	341,66
124	MG	Caratinga	91.503	804	4,77	10,82	15,59	1	2	3	2.131	0	0,17	0,39	316,20
125	MG	Patrocínio	90.041	668	4,70	10,65	15,34	1	2	3	1.742	0	0,17	0,39	258,52
126	MG	São João del Rei	89.653	470	4,68	10,60	15,28	1	2	3	1.221	0	0,17	0,39	181,11
127	MG	Manhuaçu	89.256	758	4,65	10,56	15,21	1	2	3	1.960	0	0,17	0,38	290,79
128	MG	Timóteo	89.090	783	4,65	10,54	15,18	1	2	3	2.021	0	0,17	0,38	299,82
129	MG	Unaí	83.808	962	4,37	9,91	14,28	1	2	2	2.336	0	0,16	0,36	346,53
130	MS	Campo Grande	885.711	987	46,19	104,75	150,94	8	18	26	25.326	2	1,66	3,81	3.757,39
131	MS	Dourados	220.965	982	11,52	26,13	37,66	2	4	6	6.286	1	0,41	0,95	932,63
132	MS	Três Lagoas	119.465	668	6,23	14,13	20,36	1	2	3	2.312	0	0,22	0,51	343,00
133	MS	Corumbá	110.806	1.494	5,78	13,10	18,88	1	2	3	4.796	0	0,21	0,48	711,53
134	MS	Ponta Porã	91.082	1.102	4,75	10,77	15,52	1	2	3	2.908	0	0,17	0,39	431,41
135	MT	Cuiabá	607.153	1.529	31,66	71,80	103,47	5	12	18	26.894	1	1,14	2,61	3.990,09
136	MT	Várzea Grande	282.009	1.535	14,71	33,35	48,06	3	6	8	12.541	1	0,53	1,21	1.860,58
137	MT	Rondonópolis	228.857	1.313	11,94	27,06	39,00	2	5	7	8.705	1	0,43	0,98	1.291,53
138	MT	Sinop	139.935	2.007	7,30	16,55	23,85	1	3	4	8.136	0	0,26	0,60	1.207,12
139	MT	Tangará da Serra	101.764	1.770	5,31	12,03	17,34	1	2	3	5.218	0	0,19	0,44	774,18
140	MT	Cáceres	93.882	1.747	4,90	11,10	16,00	1	2	3	4.751	0	0,18	0,40	704,94
141	MT	Sorriso	87.815	1.924	4,58	10,39	14,96	1	2	3	4.895	0	0,16	0,38	726,19
142	PA	Belém	1.485.732	2.895	77,48	175,70	253,19	13	30	43	124.606	4	2,79	6,39	18.486,97
143	PA	Ananindeua	525.566	2.877	27,41	62,15	89,56	5	11	15	43.804	1	0,99	2,26	6.498,96
144	PA	Santarém	302.667	3.295	15,78	35,79	51,58	3	6	9	28.892	1	0,57	1,30	4.286,44
145	PA	Marabá	275.086	2.346	14,35	32,53	46,88	2	6	8	18.696	1	0,52	1,18	2.773,79
146	PA	Parauapebas	202.882	2.423	10,58	23,99	34,57	2	4	6	14.241	0	0,38	0,87	2.112,87
147	PA	Castanhal	198.294	2.837	10,34	23,45	33,79	2	4	6	16.297	0	0,37	0,85	2.417,94
148	PA	Abaetetuba	156.292	2.787	8,15	18,48	26,63	1	3	5	12.619	0	0,29	0,67	1.872,19
149	PA	Cametá	136.390	2.804	7,11	16,13	23,24	1	3	4	11.079	0	0,26	0,59	1.643,76
150	PA	Marituba	129.321	2.889	6,74	15,29	22,04	1	3	4	10.823	0	0,24	0,56	1.605,81
151	PA	Bragança	126.436	2.897	6,59	14,95	21,55	1	3	4	10.611	0	0,24	0,54	1.574,33
152	PA	São Félix do Xingu	124.763	2.473	6,51	14,75	21,26	1	3	4	8.938	0	0,23	0,54	1.326,13
153	PA	Barcarena	122.294	2.818	6,38	14,46	20,84	1	2	4	9.984	0	0,23	0,53	1.481,23
154	PA	Altamira	113.195	2.847	5,90	13,39	19,29	1	2	3	9.336	0	0,21	0,49	1.385,13
155	PA	Tucuruí	112.148	2.596	5,85	13,26	19,11	1	2	3	8.434	0	0,21	0,48	1.251,33
156	PA	Paragominas	111.764	2.619	5,83	13,22	19,05	1	2	3	8.480	0	0,21	0,48	1.258,10
157	PA	Tailândia	103.664	2.629	5,41	12,26	17,67	1	2	3	7.895	0	0,19	0,45	1.171,37

158	PA	Breves	101.891	2.466	5,31	12,05	17,36	1	2	3	7.279	0	0,19	0,44	1.079,95
159	PA	Itaituba	101.097	3.002	5,27	11,96	17,23	1	2	3	8.792	0	0,19	0,43	1.304,44
160	PA	Redenção	83.997	2.077	4,38	9,93	14,31	1	2	2	5.054	0	0,16	0,36	749,85
161	PA	Moju	80.988	2.759	4,22	9,58	13,80	1	2	2	6.473	0	0,15	0,35	960,39
162	PB	João Pessoa	800.323	2.748	41,74	94,65	136,39	7	16	23	63.714	2	1,50	3,44	9.452,76
163	PB	Campina Grande	407.472	2.647	21,25	48,19	69,44	4	8	12	31.247	1	0,77	1,75	4.635,84
164	PB	Santa Rita	135.807	2.753	7,08	16,06	23,14	1	3	4	10.831	0	0,26	0,58	1.606,96
165	PB	Patos	106.984	2.609	5,58	12,65	18,23	1	2	3	8.086	0	0,20	0,46	1.199,69
166	PB	Bayeux	96.550	2.749	5,04	11,42	16,45	1	2	3	7.689	0	0,18	0,41	1.140,78
167	PE	Recife	1.637.834	2.636	85,42	193,69	279,11	15	33	47	125.074	4	3,08	7,04	18.556,32
168	PE	Jaboatão dos Guararapes	697.636	2.625	36,38	82,50	118,89	6	14	20	53.053	2	1,31	3,00	7.871,09
169	PE	Olinda	391.835	2.645	20,43	46,34	66,77	3	8	11	30.025	1	0,74	1,68	4.454,57
170	PE	Caruaru	356.872	2.535	18,61	42,20	60,82	3	7	10	26.208	1	0,67	1,53	3.888,37
171	PE	Petrolina	343.865	2.206	17,93	40,67	58,60	3	7	10	21.976	1	0,65	1,48	3.260,39
172	PE	Paulista	329.117	2.660	17,16	38,92	56,09	3	7	10	25.362	1	0,62	1,41	3.762,78
173	PE	Cabo de Santo Agostinho	205.112	2.601	10,70	24,26	34,95	2	4	6	15.455	0	0,39	0,88	2.293,02
174	PE	Camaragibe	156.736	2.641	8,17	18,54	26,71	1	3	5	11.992	0	0,29	0,67	1.779,16
175	PE	Garanhuns	138.983	2.408	7,25	16,44	23,68	1	3	4	9.695	0	0,26	0,60	1.438,45
176	PE	Vitória de Santo Antão	137.915	2.584	7,19	16,31	23,50	1	3	4	10.324	0	0,26	0,59	1.531,72
177	PE	Igarassu	115.640	2.6661	6,03	13,68	19,71	1	2	3	5.825.682	0	0,22	0,50	864.316,09
178	PE	São Lourenço da Mata	112.362	2.635	5,86	13,29	19,15	1	2	3	8.577	0	0,21	0,48	1.272,56
179	PE	Santa Cruz do Capibaribe	105.936	2.560	5,52	12,53	18,05	1	2	3	7.857	0	0,20	0,46	1.165,63
180	PE	Abreu e Lima	99.622	2.653	5,20	11,78	16,98	1	2	3	7.657	0	0,19	0,43	1.135,98
181	PE	Ipojuca	94.709	2.602	4,94	11,20	16,14	1	2	3	7.139	0	0,18	0,41	1.059,19
182	PE	Serra Talhada	85.774	2.417	4,47	10,14	14,62	1	2	2	6.006	0	0,16	0,37	891,06
183	PE	Araripina	83.964	2.647	4,38	9,93	14,31	1	2	2	6.439	0	0,16	0,36	955,26
184	PE	Gravatá	83.437	2.555	4,35	9,87	14,22	1	2	2	6.176	0	0,16	0,36	916,28
185	PE	Carpina	82.872	2.639	4,32	9,80	14,12	1	2	2	6.336	0	0,16	0,36	939,99
186	PI	Teresina	861.442	2.654	44,93	101,88	146,80	8	17	25	66.234	2	1,62	3,70	9.826,61
187	PI	Parnaíba	152.653	2.979	7,96	18,05	26,01	1	3	4	13.174	0	0,29	0,66	1.954,58
188	PR	Curitiba	1.917.185	408	99,98	226,73	326,71	17	39	56	22.661	5	3,60	8,24	3.362,02
189	PR	Londrina	563.943	537	29,41	66,69	96,10	5	11	16	8.773	1	1,06	2,42	1.301,63
190	PR	Maringá	417.010	649	21,75	49,32	71,06	4	8	12	7.840	1	0,78	1,79	1.163,24
191	PR	Ponta Grossa	348.043	516	18,15	41,16	59,31	3	7	10	5.203	1	0,65	1,50	771,90
192	PR	Cascavel	324.476	929	16,92	38,37	55,29	3	7	9	8.733	1	0,61	1,39	1.295,61
193	PR	São José dos Pinhais	317.476	409	16,56	37,55	54,10	3	6	9	3.762	1	0,60	1,36	558,10
194	PR	Foz do Iguaçu	258.823	1.058	13,50	30,61	44,11	2	5	7	7.933	1	0,49	1,11	1.176,97
195	PR	Colombo	240.840	394	12,56	28,48	41,04	2	5	7	2.749	1	0,45	1,04	407,85
196	PR	Guarapuava	180.334	670	9,40	21,33	30,73	2	4	5	3.500	0	0,34	0,78	519,31
197	PR	Paranaguá	153.666	435	8,01	18,17	26,19	1	3	4	1.937	0	0,29	0,66	287,31
198	PR	Araucária	141.410	432	7,37	16,72	24,10	1	3	4	1.770	0	0,27	0,61	262,57
199	PR	Toledo	138.572	926	7,23	16,39	23,61	1	3	4	3.717	0	0,26	0,60	551,52
200	PR	Apucarana	133.726	588	6,97	15,81	22,79	1	3	4	2.278	0	0,25	0,57	337,96
201	PR	Pinhais	130.789	402	6,82	15,47	22,29	1	3	4	1.523	0	0,25	0,56	225,98
202	PR	Campo Largo	130.091	525	6,78	15,38	22,17	1	3	4	1.979	0	0,24	0,56	293,55
203	PR	Arapongas	121.198	571	6,32	14,33	20,65	1	2	4	2.005	0	0,23	0,52	297,45
204	PR	Almirante Tamandaré	117.168	413	6,11	13,86	19,97	1	2	3	1.402	0	0,22	0,50	207,99
205	PR	Piraquara	111.052	466	5,79	13,13	18,92	1	2	3	1.499	0	0,21	0,48	222,43
206	PR	Umuarama	110.590	810	5,77	13,08	18,85	1	2	3	2.595	0	0,21	0,48	385,01
207	PR	Cambé	105.704	559	5,51	12,50	18,01	1	2	3	1.712	0	0,20	0,45	253,97
208	PR	Fazenda Rio Grande	98.368	433	5,13	11,63	16,76	1	2	3	1.234	0	0,18	0,42	183,07
209	PR	Sarandi	95.543	642	4,98	11,30	16,28	1	2	3	1.777	0	0,18	0,41	263,64
210	PR	Campo Mourão	94.212	737	4,91	11,14	16,05	1	2	3	2.012	0	0,18	0,40	298,44
211	PR	Francisco Beltrão	89.942	885	4,69	10,64	15,33	1	2	3	2.306	0	0,17	0,39	342,12
212	PR	Paranavaí	87.813	719	4,58	10,38	14,96	1	2	3	1.829	0	0,16	0,38	271,37
213	PR	Pato Branco	81.893	853	4,27	9,68	13,96	1	2	2	2.024	0	0,15	0,35	300,24
214	PR	Cianorte	81.393	711	4,24	9,63	13,87	1	2	2	1.677	0	0,15	0,35	248,73
215	RJ	Rio de Janeiro	6.688.927	444	348,84	791,04	1.139,88	59	134	194	86.038	16	12,56	28,75	12.764,86
216	RJ	São Gonçalo	1.077.687	462	56,20	127,45	183,65	10	22	31	14.424	3	2,02	4,63	2.139,99
217	RJ	Duque de Caxias	914.383	422	47,69	108,14	155,82	8	18	26	11.179	2	1,72	3,93	1.658,51
218	RJ	Nova Iguaçu	818.875	408	42,71	96,84	139,55	7	16	24	9.679	2	1,54	3,52	1.436,00
219	RJ	Niterói	511.786	449	26,69	60,52	87,21	5	10	15	6.657	1	0,96	2,20	987,67
220	RJ	Belford Roxo	508.614	410	26,52	60,15	86,67	5	10	15	6.041	1	0,96	2,19	896,29
221	RJ	Campos dos Goytacazes	503.424	709	26,25	59,54	85,79	4	10	15	10.340	1	0,95	2,16	1.534,11
222	RJ	São João de Meriti	471.888	417	24,61	55,81	80,42	4	9	14	5.701	1	0,89	2,03	845,77
223	RJ	Petrópolis	305.687	458	15,94	36,15	52,09	3	6	9	4.056	1	0,57	1,31	601,75
224	RJ	Volta Redonda	271.998	327	14,19	32,17	46,35	2	5	8	2.577	1	0,51	1,17	382,29
225	RJ	Macaé	251.631	618	13,12	29,76	42,88	2	5	7	4.505	1	0,47	1,08	668,39
226	RJ	Magé	243.657	454	12,71	28,82	41,52	2	5	7	3.205	1	0,46	1,05	475,46
227	RJ	Itaboraí	238.695	480	12,45	28,23	40,68	2	5	7	3.319	1	0,45	1,03	492,45
228	RJ	Cabo Frio	222.528	583	11,61	26,32	37,92	2	4	6	3.758	1	0,42	0,96	557,61
229	RJ	Angra dos Reis	200.407	405	10,45	23,70	34,15	2	4	6	2.351	0	0,38	0,86	348,85
230	RJ	Nova Friburgo	190.084	546	9,91	22,48	32,39	2	4	6	3.007	0	0,36	0,82	446,08
231	RJ	Barra Mansa	183.976	312	9,59	21,76	31,35	2	4	5	1.663	0	0,35	0,79	246,71
232	RJ	Teresópolis	180.886	491	9,43	21,39	30,83	2	4	5	2.573	0	0,34	0,78	381,74
233	RJ	Mesquita	175.620	409	9,16	20,77	29,93	2	4	5	2.081	0	0,33	0,75	308,73
234	RJ	Nilópolis	162.269	416	8,46	19,19	27,65	1	3	5	1.956	0	0,30	0,70	290,14
235	RJ	Maricá	157.789	489	8,23	18,66	26,89	1	3	5	2.235	0	0,30	0,68	331,64
236	RJ	Queimados	149.265	395	7,78	17,65	25,44	1	3	4	1.708	0	0,28	0,64	253,41

237	RJ	Rio das Ostras	145.989	597	7,61	17,26	24,88	1	3	4	2.525	0	0,27	0,63	374,60
238	RJ	Araruama	130.439	547	6,80	15,43	22,23	1	3	4	2.067	0	0,24	0,56	306,67
239	RJ	Resende	130.334	283	6,80	15,41	22,21	1	3	4	1.069	0	0,24	0,56	158,53
240	RJ	Itaguaí	125.913	408	6,57	14,89	21,46	1	3	4	1.488	0	0,24	0,54	220,80
241	RJ	Japeri	103.960	387	5,42	12,29	17,72	1	2	3	1.166	0	0,20	0,45	172,92
242	RJ	São Pedro da Aldeia	102.846	571	5,36	12,16	17,53	1	2	3	1.701	0	0,19	0,44	252,41
243	RJ	Itaperuna	102.626	647	5,35	12,14	17,49	1	2	3	1.924	0	0,19	0,44	285,39
244	RJ	Barra do Piraí	99.969	359	5,21	11,82	17,04	1	2	3	1.040	0	0,19	0,43	154,25
245	RJ	Saquarema	87.704	542	4,57	10,37	14,95	1	2	3	1.377	0	0,16	0,38	204,31
246	RJ	Seropédica	86.743	380	4,52	10,26	14,78	1	2	3	955	0	0,16	0,37	141,68
247	RJ	Três Rios	81.453	443	4,25	9,63	13,88	1	2	2	1.045	0	0,15	0,35	155,09
248	RN	Natal	877.640	3.075	45,77	103,79	149,56	8	18	25	78.183	2	1,65	3,77	11.599,47
249	RN	Mossoró	294.076	2.766	15,34	34,78	50,11	3	6	9	23.565	1	0,55	1,26	3.496,14
250	RN	Parnamirim	255.793	3.055	13,34	30,25	43,59	2	5	7	22.639	1	0,48	1,10	3.358,74
251	RN	São Gonçalo do Amarante	101.102	3.079	5,27	11,96	17,23	1	2	3	9.018	0	0,19	0,43	1.337,97
252	RO	Porto Velho	519.531	2.987	27,09	61,44	88,53	5	10	15	44.957	1	0,98	2,23	6.669,96
253	RO	Ji-Paraná	127.907	2.616	6,67	15,13	21,80	1	3	4	9.694	0	0,24	0,55	1.438,17
254	RO	Ariquemes	106.168	2.791	5,54	12,56	18,09	1	2	3	8.584	0	0,20	0,46	1.273,59
255	RO	Vilhena	97.448	2.283	5,08	11,52	16,61	1	2	3	6.445	0	0,18	0,42	956,21
256	RO	Cacoal	84.813	2.509	4,42	10,03	14,45	1	2	2	6.165	0	0,16	0,36	914,62
257	RR	Boa Vista	375.374	4.657	19,58	44,39	63,97	3	8	11	50.643	1	0,70	1,61	7.513,58
258	RS	Porto Alegre	1.479.101	1.130	77,14	174,92	252,06	13	30	43	48.420	4	2,78	6,36	7.183,78
259	RS	Caxias do Sul	504.069	977	26,29	59,61	85,90	4	10	15	14.267	1	0,95	2,17	2.116,71
260	RS	Canoas	344.957	1.128	17,99	40,80	58,79	3	7	10	11.273	1	0,65	1,48	1.672,44
261	RS	Pelotas	341.648	1.380	17,82	40,40	58,22	3	7	10	13.659	1	0,64	1,47	2.026,44
262	RS	Santa Maria	280.505	1.258	14,63	33,17	47,80	2	6	8	10.223	1	0,53	1,21	1.516,69
263	RS	Gravataí	279.398	1.105	14,57	33,04	47,61	2	6	8	8.944	1	0,52	1,20	1.326,97
264	RS	Viamão	254.101	1.128	13,25	30,05	43,30	2	5	7	8.304	1	0,48	1,09	1.231,95
265	RS	Novo Hamburgo	246.452	1.143	12,85	29,15	42,00	2	5	7	8.161	1	0,46	1,06	1.210,75
266	RS	São Leopoldo	234.947	1.134	12,25	27,79	40,04	2	5	7	7.719	1	0,44	1,01	1.145,14
267	RS	Rio Grande	210.005	1.352	10,95	24,84	35,79	2	4	6	8.225	1	0,39	0,90	1.220,35
268	RS	Alvorada	209.213	1.120	10,91	24,74	35,65	2	4	6	6.788	1	0,39	0,90	1.007,12
269	RS	Passo Fundo	201.767	957	10,52	23,86	34,38	2	4	6	5.594	0	0,38	0,87	829,92
270	RS	Sapucaia do Sul	140.311	1.124	7,32	16,59	23,91	1	3	4	4.569	0	0,26	0,60	677,85
271	RS	Santa Cruz do Sul	129.427	1.271	6,75	15,31	22,06	1	3	4	4.766	0	0,24	0,56	707,05
272	RS	Cachoeirinha	129.307	1.113	6,74	15,29	22,04	1	3	4	4.169	0	0,24	0,56	618,58
273	RS	Uruguaiana	127.079	1.570	6,63	15,03	21,66	1	3	4	5.780	0	0,24	0,55	857,53
274	RS	Bagé	120.943	1.496	6,31	14,30	20,61	1	2	4	5.242	0	0,23	0,52	777,66
275	RS	Bento Gonçalves	119.049	1.017	6,21	14,08	20,29	1	2	3	3.507	0	0,22	0,51	520,38
276	RS	Erechim	105.059	877	5,48	12,42	17,90	1	2	3	2.669	0	0,20	0,45	396,01
277	RS	Guaíba	98.043	1.149	5,11	11,59	16,71	1	2	3	3.264	0	0,18	0,42	484,19
278	RS	Ijuí	83.173	1.122	4,34	9,84	14,17	1	2	2	2.703	0	0,16	0,36	401,10
279	RS	Esteio	83.121	1.128	4,33	9,83	14,16	1	2	2	2.716	0	0,16	0,36	402,99
280	RS	Lajeado	82.951	1.077	4,33	9,81	14,14	1	2	2	2.588	0	0,16	0,36	383,98
281	RS	Cachoeira do Sul	82.547	1.319	4,30	9,76	14,07	1	2	2	3.154	0	0,16	0,35	467,98
282	RS	Sapiranga	81.198	1.125	4,23	9,60	13,84	1	2	2	2.646	0	0,15	0,35	392,62
283	SC	Joinville	583.144	583	30,41	68,96	99,38	5	12	17	9.849	1	1,09	2,51	1.461,24
284	SC	Florianópolis	492.977	758	25,71	58,30	84,01	4	10	14	10.825	1	0,93	2,12	1.606,10
285	SC	Blumenau	352.460	637	18,38	41,68	60,06	3	7	10	6.504	1	0,66	1,51	965,00
286	SC	São José	242.927	746	12,67	28,73	41,40	2	5	7	5.250	1	0,46	1,04	778,92
287	SC	Chapecó	216.654	879	11,30	25,62	36,92	2	4	6	5.517	1	0,41	0,93	818,53
288	SC	Itajaí	215.895	662	11,26	25,53	36,79	2	4	6	4.140	1	0,41	0,93	614,30
289	SC	Criciúma	213.023	938	11,11	25,19	36,30	2	4	6	5.789	1	0,40	0,92	858,83
290	SC	Jaraguá do Sul	174.158	571	9,08	20,60	29,68	2	4	5	2.881	0	0,33	0,75	427,42
291	SC	Palhoça	168.259	755	8,77	19,90	28,67	1	3	5	3.680	0	0,32	0,72	546,01
292	SC	Lages	157.743	765	8,23	18,65	26,88	1	3	5	3.496	0	0,30	0,68	518,67
293	SC	Balneário Camboriú	138.732	675	7,24	16,41	23,64	1	3	4	2.713	0	0,26	0,60	402,49
294	SC	Brusque	131.703	694	6,87	15,58	22,44	1	3	4	2.648	0	0,25	0,57	392,85
295	SC	Tubarão	104.937	874	5,47	12,41	17,88	1	2	3	2.657	0	0,20	0,45	394,20
296	SC	São Bento do Sul	83.576	511	4,36	9,88	14,24	1	2	2	1.237	0	0,16	0,36	183,56
297	SC	Camboriú	80.834	675	4,22	9,56	13,78	1	2	2	1.581	0	0,15	0,35	234,52
298	SE	Aracaju	648.939	2.155	33,84	76,74	110,59	6	13	19	40.514	2	1,22	2,79	6.010,74
299	SE	Nossa Senhora do Socorro	181.503	2.153	9,47	21,46	30,93	2	4	5	11.321	0	0,34	0,78	1.679,59
300	SE	Lagarto	103.576	2.119	5,40	12,25	17,65	1	2	3	6.358	0	0,19	0,45	943,34
301	SE	Itabaiana	94.696	2.158	4,94	11,20	16,14	1	2	3	5.920	0	0,18	0,41	878,33
302	SE	São Cristóvão	89.027	2.143	4,64	10,53	15,17	1	2	3	5.527	0	0,17	0,38	820,01
303	SP	São Paulo	12.176.866		635,04	1440,05	2.075,09	108	245	353	0	29	22,87	52,34	0,00
304	SP	Guarulhos	1.365.899	20	71,23	161,53	232,77	12	27	40	791	3	2,56	5,87	117,42
305	SP	Campinas	1.194.094	99	62,27	141,22	203,49	11	24	35	3.425	3	2,24	5,13	508,10
306	SP	São Bernardo do Campo	833.240	22,7	43,45	98,54	141,99	7	17	24	548	2	1,56	3,58	81,30
307	SP	Santo André	716.109	23,7	37,35	84,69	122,03	6	14	21	492	2	1,34	3,08	72,95
308	SP	São José dos Campos	713.943	97,4	37,23	84,43	121,66	6	14	21	2.015	2	1,34	3,07	298,88
309	SP	Osasco	696.850	23,4	36,34	82,41	118,75	6	14	20	472	2	1,31	3,00	70,09
310	SP	Ribeirão Preto	694.534	316	36,22	82,14	118,36	6	14	20	6.358	2	1,30	2,99	943,32
311	SP	Sorocaba	671.186	104	35,00	79,38	114,38	6	13	19	2.022	2	1,26	2,88	300,02
312	SP	Mauá	468.148	27,1	24,41	55,36	79,78	4	9	14	368	1	0,88	2,01	54,53
313	SP	São José do Rio Preto	456.245	440	23,79	53,96	77,75	4	9	13	5.816	1	0,86	1,96	862,83
314	SP	Mogi das Cruzes	440.769	63,7	22,99	52,13	75,11	4	9	13	813	1	0,83	1,89	120,68
315	SP	Santos	432.957	81,2	22,58	51,20	73,78	4	9	13	1.018	1	0,81	1,86	151,10

316	SP	Diadema	420.934	22,6	21,95	49,78	71,73	4	8	12	276	1	0,79	1,81	40,89
317	SP	Jundiaí	414.810	58,8	21,63	49,06	70,69	4	8	12	707	1	0,78	1,78	104,83
318	SP	Piracicaba	400.949	157	20,91	47,42	68,33	4	8	12	1.824	1	0,75	1,72	270,56
319	SP	Carapicuíba	398.611	30	20,79	47,14	67,93	4	8	12	346	1	0,75	1,71	51,40
320	SP	Bauru	374.272	332	19,52	44,26	63,78	3	8	11	3.600	1	0,70	1,61	534,07
321	SP	Itaquaquecetuba	366.519	43,5	19,11	43,34	62,46	3	7	11	462	1	0,69	1,58	68,53
322	SP	São Vicente	363.173	73	18,94	42,95	61,89	3	7	11	768	1	0,68	1,56	113,95
323	SP	Franca	350.400	400	18,27	41,44	59,71	3	7	10	4.060	1	0,66	1,51	602,42
324	SP	Praia Grande	319.146	77,6	16,64	37,74	54,39	3	6	9	717	1	0,60	1,37	106,45
325	SP	Guarujá	318.107	98,9	16,59	37,62	54,21	3	6	9	911	1	0,60	1,37	135,22
326	SP	Taubaté	311.854	140	16,26	36,88	53,14	3	6	9	1.265	1	0,59	1,34	187,65
327	SP	Limeira	303.682	163	15,84	35,91	51,75	3	6	9	1.434	1	0,57	1,31	212,76
328	SP	Suzano	294.638	51,7	15,37	34,84	50,21	3	6	9	441	1	0,55	1,27	65,47
329	SP	Taboão da Serra	285.570	18,9	14,89	33,77	48,66	3	6	8	156	1	0,54	1,23	23,20
330	SP	Sumaré	278.571	119	14,53	32,94	47,47	2	6	8	960	1	0,52	1,20	142,48
331	SP	Barueri	271.306	31,7	14,15	32,08	46,23	2	5	8	249	1	0,51	1,17	36,97
332	SP	Embu das Artes	270.843	31,1	14,12	32,03	46,16	2	5	8	244	1	0,51	1,16	36,20
333	SP	São Carlos	249.415	234	13,01	29,50	42,50	2	5	7	1.691	1	0,47	1,07	250,85
334	SP	Indaiatuba	246.908	103	12,88	29,20	42,08	2	5	7	737	1	0,46	1,06	109,31
335	SP	Cotia	244.694	34	12,76	28,94	41,70	2	5	7	241	1	0,46	1,05	35,76
336	SP	Marília	237.130	437	12,37	28,04	40,41	2	5	7	3.002	1	0,45	1,02	445,39
337	SP	Americana	237.112	129	12,37	28,04	40,41	2	5	7	886	1	0,45	1,02	131,47
338	SP	Itapevi	234.352	42,6	12,22	27,71	39,94	2	5	7	289	1	0,44	1,01	42,91
339	SP	Araraquara	233.744	277	12,19	27,64	39,83	2	5	7	1.876	1	0,44	1,00	278,29
340	SP	Jacareí	231.863	89,9	12,09	27,42	39,51	2	5	7	604	1	0,44	1,00	89,59
341	SP	Hortolândia	227.353	115	11,86	26,89	38,74	2	5	7	757	1	0,43	0,98	112,38
342	SP	Presidente Prudente	227.072	558	11,84	26,85	38,70	2	5	7	3.671	1	0,43	0,98	544,60
343	SP	Rio Claro	204.797	188	10,68	24,22	34,90	2	4	6	1.115	0	0,38	0,88	165,48
344	SP	Araçatuba	195.874	522	10,22	23,16	33,38	2	4	6	2.962	0	0,37	0,84	439,46
345	SP	Santa Bárbara d'Oeste	192.536	139	10,04	22,77	32,81	2	4	6	775	0	0,36	0,83	115,03
346	SP	Ferraz de Vasconcelos	191.993	32	10,01	22,71	32,72	2	4	6	178	0	0,36	0,83	26,41
347	SP	Francisco Morato	174.008	47,7	9,07	20,58	29,65	2	3	5	240	0	0,33	0,75	35,68
348	SP	Itapecerica da Serra	173.672	36,7	9,06	20,54	29,60	2	3	5	185	0	0,33	0,75	27,40
349	SP	Itu	172.268	103	8,98	20,37	29,36	2	3	5	514	0	0,32	0,74	76,26
350	SP	Bragança Paulista	166.753	87,5	8,70	19,72	28,42	1	3	5	423	0	0,31	0,72	62,71
351	SP	Pindamonhangaba	166.475	157	8,68	19,69	28,37	1	3	5	757	0	0,31	0,72	112,34
352	SP	Itapetininga	162.231	180	8,46	19,19	27,65	1	3	5	846	0	0,30	0,70	125,51
353	SP	São Caetano do Sul	160.275	12,7	8,36	18,95	27,31	1	3	5	59	0	0,30	0,69	8,75
354	SP	Franco da Rocha	152.433	43,3	7,95	18,03	25,98	1	3	4	191	0	0,29	0,66	28,37
355	SP	Mogi Guaçu	150.713	162	7,86	17,82	25,68	1	3	4	707	0	0,28	0,65	104,94
356	SP	Jaú	148.581	299	7,75	17,57	25,32	1	3	4	1.287	0	0,28	0,64	190,95
357	SP	Botucatu	144.820	238	7,55	17,13	24,68	1	3	4	999	0	0,27	0,62	148,14
358	SP	Atibaia	141.398	67,7	7,37	16,72	24,10	1	3	4	277	0	0,27	0,61	41,14
359	SP	Santana de Parnaíba	136.517	41,5	7,12	16,14	23,26	1	3	4	164	0	0,26	0,59	24,35
360	SP	Araras	132.934	172	6,93	15,72	22,65	1	3	4	662	0	0,25	0,57	98,27
361	SP	Cubatão	129.760	70,7	6,77	15,35	22,11	1	3	4	266	0	0,24	0,56	39,43
362	SP	Valinhos	127.123	91,8	6,63	15,03	21,66	1	3	4	338	0	0,24	0,55	50,16
363	SP	Sertãozinho	124.453	336	6,49	14,72	21,21	1	3	4	1.211	0	0,23	0,53	179,73
364	SP	Jandira	123.481	38	6,44	14,60	21,04	1	2	4	136	0	0,23	0,53	20,17
365	SP	Ribeirão Pires	122.607	49,5	6,39	14,50	20,89	1	2	4	176	0	0,23	0,53	26,09
366	SP	Birigui	122.359	514	6,38	14,47	20,85	1	2	4	1.822	0	0,23	0,53	270,32
367	SP	Barretos	121.344	423	6,33	14,35	20,68	1	2	4	1.487	0	0,23	0,52	220,62
368	SP	Votorantim	121.331	105	6,33	14,35	20,68	1	2	4	369	0	0,23	0,52	54,76
369	SP	Catanduva	121.210	386	6,32	14,33	20,66	1	2	4	1.355	0	0,23	0,52	201,10
370	SP	Guaratinguetá	121.073	188	6,31	14,32	20,63	1	2	4	659	0	0,23	0,52	97,83
371	SP	Várzea Paulista	120.572	59,4	6,29	14,26	20,55	1	2	3	207	0	0,23	0,52	30,78
372	SP	Tatuí	120.533	143	6,29	14,25	20,54	1	2	3	499	0	0,23	0,52	74,08
373	SP	Caraguatatuba	119.625	181	6,24	14,15	20,39	1	2	3	627	0	0,22	0,51	93,06
374	SP	Itatiba	119.090	83,6	6,21	14,08	20,29	1	2	3	288	0	0,22	0,51	42,79
375	SP	Salto	117.561	103	6,13	13,90	20,03	1	2	3	351	0	0,22	0,51	52,04
376	SP	Poá	116.530	47,7	6,08	13,78	19,86	1	2	3	161	0	0,22	0,50	23,89
377	SP	Ourinhos	112.711	373	5,88	13,33	19,21	1	2	3	1.218	0	0,21	0,48	180,70
378	SP	Paulínia	106.776	122	5,57	12,63	18,20	1	2	3	377	0	0,20	0,46	55,99
379	SP	Assis	103.666	438	5,41	12,26	17,67	1	2	3	1.315	0	0,19	0,45	195,16
380	SP	Leme	102.412	189	5,34	12,11	17,45	1	2	3	561	0	0,19	0,44	83,19
381	SP	Itanhaém	100.496	115	5,24	11,88	17,13	1	2	3	335	0	0,19	0,43	49,67
382	SP	Caieiras	100.129	36,7	5,22	11,84	17,06	1	2	3	106	0	0,19	0,43	15,79
383	SP	Mairiporã	98.374	38	5,13	11,63	16,76	1	2	3	108	0	0,18	0,42	16,07
384	SP	Itapeva	93.892	292	4,90	11,10	16,00	1	2	3	794	0	0,18	0,40	117,84
385	SP	Votuporanga	93.736	521	4,89	11,09	15,97	1	2	3	1.415	0	0,18	0,40	209,90
386	SP	Caçapava	93.488	114	4,88	11,06	15,93	1	2	3	309	0	0,18	0,40	45,81
387	SP	Mogi Mirim	92.715	153	4,84	10,96	15,80	1	2	3	411	0	0,17	0,40	60,97
388	SP	São João da Boa Vista	90.637	217	4,73	10,72	15,45	1	2	3	570	0	0,17	0,39	84,54
389	SP	Avaré	90.063	267	4,70	10,65	15,35	1	2	3	697	0	0,17	0,39	103,36
390	SP	São Roque	89.943	69,9	4,69	10,64	15,33	1	2	3	182	0	0,17	0,39	27,02
391	SP	Ubatuba	89.747	225	4,68	10,61	15,29	1	2	3	585	0	0,17	0,39	86,79
392	SP	Arujá	88.455	51,8	4,61	10,46	15,07	1	2	3	133	0	0,17	0,38	19,69
393	SP	Lorena	88.276	200	4,60	10,44	15,04	1	2	3	511	0	0,17	0,38	75,88
394	SP	São Sebastião	87.596	204	4,57	10,36	14,93	1	2	3	518	0	0,16	0,38	76,81
395	SP	Campo Limpo Paulista	83.735	63,3	4,37	9,90	14,27	1	2	2	154	0	0,16	0,36	22,78
396	SP	Matão	82.702	306	4,31	9,78	14,09	1	2	2	733	0	0,16	0,36	108,77

397	SP	Cruzeiro	81.895	227	4,27	9,69	13,96	1	2	2	539	0	0,15	0,35	79,90
398	TO	Palmas	291.855	1.814	15,22	34,52	49,74	3	6	8	15.338	1	0,55	1,25	2.275,52
399	TO	Araguaína	177.517	2.070	9,26	20,99	30,25	2	4	5	10.645	0	0,33	0,76	1.579,38
400	TO	Gurupi	85.737	1.528	4,47	10,14	14,61	1	2	2	3.795	0	0,16	0,37	563,08
			126.305.149		6.587	14937	21.524	1.120	2.539	3.659	9.806.655	306	237,17	542,87	1.454.946

Total of 400 municipalities included in RL					Smartphones waste generation	Laptops waste generation				Target RL - smartphones	Target RL - laptops		RL-WEEE				RL-LIBs
Nº	State	City	Population	Distance to São Paulo city and state	Unit (2026)	Unit (2026)	PERCAPITA WEIGHT-SMARTPHONES BY CITY	PERCAPITA WEIGHT-LAPTOPS BY CITY	WEIGHT	50%	50%	Total WEEE 2026	tkm/year/city WEEE	Allocation tkm/year for LIBs (% weight of smartphones 27,3%)	Allocation tkm/year for LIBs (% weight of laptops (9,34%)	Total LIBs weight	tkm/year/city for LIBs
1	AC	Rio Branco	401.155	3.500	42.371.106	5.919.152	20,80	50,97	71,76	10	25	36	125.586	3	2	5	18.266,23
2	AC	Cruzeiro do Sul	87.673	4.130			4,55	11,14	15,68	2	6	8	32.387	1	1	1	4.710,69
3	AL	Maceió	1.012.382	2.408	Mass (t)	Mass (t)	52,48	128,62	181,11	26	64	91	218.053	7	6	13	31.715,35
4	AL	Arapiraca	230.417	2.306	6.548	16.047	11,95	29,27	41,22	6	15	21	47.526	2	1	3	6.912,62
5	AM	Manaus	2.145.444	3.876			111,23	272,58	383,80	56	136	192	743.810	15	13	28	108.185,61
6	AM	Parintins	113.168	2.560	Percapita unit	Percapita unit	5,87	14,38	20,24	3	7	10	25.913	1	1	1	3.769,05
7	AM	Itacoatiara	99.955	4.143	0,3354661779	0,04686389832	5,18	12,70	17,88	3	6	9	37.041	1	1	1	5.387,51
8	AM	Manacapuru	96.236	3.975			4,99	12,23	17,22	2	6	9	34.217	1	1	1	4.976,72
9	AM	Coari	84.272	2.795	Percapita weight	Percapita weight	4,37	10,71	15,08	2	5	8	21.068	1	1	1	3.064,32
10	AP	Macapá	493.634	3.404	0,00005184270041	0,0001270494523	25,59	62,72	88,31	13	31	44	150.299	3	3	6	21.860,65
11	AP	Santana	119.610	3.423	t/people/year	t/people/year	6,20	15,20	21,40	3	8	11	36.621	1	1	2	5.326,51
12	BA	Salvador	2.857.329	1.961			148,13	363,02	511,15	74	182	256	501.186	20	17	37	72.896,45
13	BA	Feira de Santana	609.913	1.875			31,62	77,49	109,11	16	39	55	102.289	4	4	8	14.877,77
14	BA	Vitória da Conquista	338.885	1.600			17,57	43,06	60,62	9	22	30	48.499	2	2	4	7.054,09
15	BA	Camaçari	293.723	1.950			15,23	37,32	52,54	8	19	26	51.231	2	2	4	7.451,46
16	BA	Juazeiro	215.183	2.201			11,16	27,34	38,49	6	14	19	42.363	2	1	3	6.161,64
17	BA	Itabuna	212.740	1.815			11,03	27,03	38,06	6	14	19	34.537	2	1	3	5.023,36
18	BA	Lauro de Freitas	195.095	1.956			10,11	24,79	34,90	5	12	17	34.133	1	1	3	4.964,59
19	BA	Ilhéus	164.844	1.691			8,55	20,94	29,49	4	10	15	24.933	1	1	2	3.626,48
20	BA	Teixeira de Freitas	158.445	1.286			8,21	20,13	28,34	4	10	14	18.226	1	1	2	2.650,87
21	BA	Jequié	155.800	1.753			8,08	19,79	27,87	4	10	14	24.429	1	1	2	3.553,19
22	BA	Barreiras	153.831	1.584			7,98	19,54	27,52	4	10	14	21.795	1	1	2	3.170,06
23	BA	Alagoinhas	150.832	1.924			7,82	19,16	26,98	4	10	13	25.957	1	1	2	3.775,44
24	BA	Porto Seguro	146.625	1.844			7,60	18,63	26,23	4	9	13	24.184	1	1	2	3.517,53
25	BA	Simões Filho	132.906	1.937			6,89	16,89	23,78	3	8	12	23.027	1	1	2	3.349,21
26	BA	Paulo Afonso	117.014	2.209			6,07	14,87	20,93	3	7	10	23.120	1	1	2	3.362,81
27	BA	Eunápolis	112.318	1.781			5,82	14,27	20,09	3	7	10	17.893	1	1	1	2.602,45
28	BA	Santo Antônio de Jesus	100.605	1.782			5,22	12,78	18,00	3	6	9	16.036	1	1	1	2.332,36
29	BA	Valença	95.858	1.801			4,97	12,18	17,15	2	6	9	15.442	1	1	1	2.246,00
30	BA	Candeias	86.677	1.916			4,49	11,01	15,51	2	6	8	14.855	1	1	1	2.160,57
31	BA	Luís Eduardo Magalhães	84.753	1.517			4,39	10,77	15,16	2	5	8	11.500	1	1	1	1.672,67
32	BA	Guanambi	84.014	1.347			4,36	10,67	15,03	2	5	8	10.122	1	0	1	1.472,27
33	BA	Serrinha	80.411	1.911			4,17	10,22	14,38	2	5	7	13.745	1	0	1	1.999,15
34	BA	Jacobina	80.394	1.977			4,17	10,21	14,38	2	5	7	14.216	1	0	1	2.067,75
35	CE	Fortaleza	2.643.247	2.904			137,03	335,82	472,86	69	168	236	686.587	19	16	34	99.862,61
36	CE	Caucaia	363.982	3.081			18,87	46,24	65,11	9	23	33	100.307	3	2	5	14.589,49
37	CE	Juazeiro do Norte	271.926	2.456			14,10	34,55	48,65	7	17	24	59.737	2	2	4	8.688,56
38	CE	Maracanaú	226.128	3.090			11,72	28,73	40,45	6	14	20	62.499	2	1	3	9.090,37
39	CE	Sobral	206.644	3.005			10,71	26,25	36,97	5	13	18	55.543	1	1	3	8.078,59
40	CE	Crato	131.372	2.464			6,81	16,69	23,50	3	8	12	28.954	1	1	2	4.211,26
41	CE	Itapipoca	128.135	3.103			6,64	16,28	22,92	3	8	11	35.564	1	1	2	5.172,71
42	CE	Maranguape	127.098	3.073			6,59	16,15	22,74	3	8	11	34.935	1	1	2	5.081,24
43	CE	Iguatu	103.255	2.842			5,35	13,12	18,47	3	7	9	26.248	1	1	1	3.817,72
44	CE	Quixadá	87.116	2.974			4,52	11,07	15,58	2	6	8	23.174	1	1	1	3.370,60
45	CE	Pacatuba	83.157	3.082			4,31	10,57	14,88	2	5	7	22.924	1	0	1	3.334,26
46	DF	Brasília	2.974.703	1.008			154,22	377,93	532,15	77	189	266	268.204	21	18	39	39.009,71
47	ES	Serra	507.598	977			26,32	64,49	90,81	13	32	45	44.358	4	3	7	6.451,83
48	ES	Vila Velha	486.208	945			25,21	61,77	86,98	13	31	43	41.097	3	3	6	5.977,54
49	ES	Cariacica	378.603	948			19,63	48,10	67,73	10	24	34	32.104	3	2	5	4.669,40
50	ES	Vitória	358.267	946			18,57	45,52	64,09	9	23	32	30.315	3	2	5	4.409,27
51	ES	Cachoeiro de Itapemirim	207.324	828			10,75	26,34	37,09	5	13	19	15.355	1	1	3	2.233,31
52	ES	Linhares	170.364	1.086			8,83	21,64	30,48	4	11	15	16.549	1	1	2	2.407,00
53	ES	São Mateus	128.542	1.168			6,66	16,33	23,00	3	8	11	13.429	1	1	2	1.953,24
54	ES	Guarapari	122.982	906			6,38	15,62	22,00	3	8	11	9.966	1	1	2	1.449,57
55	ES	Colatina	121.580	1.084			6,30	15,45	21,75	3	8	11	11.788	1	1	2	1.714,59
56	ES	Aracruz	99.305	1.035			5,15	12,62	17,76	3	6	9	9.193	1	1	1	1.337,15
57	GO	Goiânia	1.495.705	930			77,54	190,03	267,57	39	95	134	124.420	11	9	19	18.096,62
58	GO	Aparecida de Goiânia	565.957	911			29,34	71,90	101,25	15	36	51	46.117	4	3	7	6.707,65
59	GO	Anápolis	381.970	982			19,80	48,53	68,33	10	24	34	33.551	3	2	5	4.879,88
60	GO	Rio Verde	229.651	927			11,91	29,18	41,08	6	15	21	19.042	2	1	3	2.769,60
61	GO	Águas Lindas de Goiás	207.070	1.035			10,74	26,31	37,04	5	13	19	19.170	1	1	3	2.788,21
62	GO	Luziânia	205.023	952			10,63	26,05	36,68	5	13	18	17.458	1	1	3	2.539,27
63	GO	Valparaíso de Goiás	164.723	970			8,54	20,93	29,47	4	10	15	14.292	1	1	2	2.078,71
64	GO	Trindade	125.328	953			6,50	15,92	22,42	3	8	11	10.683	1	1	2	1.553,85
65	GO	Formosa	119.506	1.053			6,20	15,18	21,38	3	8	11	11.256	1	1	2	1.637,14
66	GO	Novo Gama	113.679	979			5,89	14,44	20,34	3	7	10	9.955	1	1	1	1.447,88
67	GO	Senador Canedo	112.224	917			5,82	14,26	20,08	3	7	10	9.205	1	1	1	1.338,82
68	GO	Catalão	106.618	694			5,53	13,55	19,07	3	7	10	6.618	1	1	1	962,63
69	GO	Itumbiara	103.652	725			5,37	13,17	18,54	3	7	9	6.722	1	1	1	977,65
70	GO	Jataí	99.674	978			5,17	12,66	17,83	3	6	9	8.719	1	1	1	1.268,20
71	GO	Planaltina	89.181	1.041			4,62	11,33	15,95	2	6	8	8.304	1	1	1	1.207,79
72	GO	Caldas Novas	89.087	758			4,62	11,32	15,94	2	6	8	6.040	1	1	1	878,52
73	MA	São Luís	1.094.667	2.935			56,75	139,08	195,83	28	70	98	287.377	8	6	14	41.798,31
74	MA	Imperatriz	258.016	2.330			13,38	32,78	46,16	7	16	23	53.773	2	2	3	7.821,16
75	MA	São José de Ribamar	176.321	2.947			9,14	22,40	31,54	5	11	16	46.478	1	1	2	6.760,09

76	MA	Timon	167.973	2.656	8,71	21,34	30,05	4	11	15	39.905	1	1	2	5.804,12
77	MA	Caxias	164.224	2.676	8,51	20,86	29,38	4	10	15	39.308	1	1	2	5.717,30
78	MA	Codó	122.597	2.774	6,36	15,58	21,93	3	8	11	30.419	1	1	2	4.424,40
79	MA	Paço do Lumiar	120.621	2.939	6,25	15,32	21,58	3	8	11	31.709	1	1	2	4.612,02
80	MA	Açailândia	111.757	2.382	5,79	14,20	19,99	3	7	10	23.811	1	1	1	3.463,26
81	MA	Bacabal	104.633	2.693	5,42	13,29	18,72	3	7	9	25.204	1	1	1	3.665,84
82	MA	Balsas	93.826	2.262	4,86	11,92	16,78	2	6	8	18.984	1	1	1	2.761,11
83	MA	Santa Inês	88.590	2.699	4,59	11,26	15,85	2	6	8	21.387	1	1	1	3.110,69
84	MA	Barra do Corda	87.794	2.489	4,55	11,15	15,71	2	6	8	19.546	1	1	1	2.842,88
85	MA	Pinheiro	82.990	2.875	4,30	10,54	14,85	2	5	7	21.341	1	0	1	3.104,07
86	MG	Belo Horizonte	2.501.576	584	129,69	317,82	447,51	65	159	224	130.674	18	15	33	19.006,19
87	MG	Uberlândia	683.247	587	35,42	86,81	122,23	18	43	61	35.874	5	4	9	5.217,76
88	MG	Contagem	659.070	573	34,17	83,73	117,90	17	42	59	33.779	5	4	9	4.913,09
89	MG	Juiz de Fora	564.310	508	29,26	71,70	100,95	15	36	50	25.641	4	3	7	3.729,49
90	MG	Betim	432.575	590	22,43	54,96	77,38	11	27	39	22.828	3	3	6	3.320,34
91	MG	Montes Claros	404.804	980	20,99	51,43	72,42	10	26	36	35.484	3	2	5	5.161,07
92	MG	Ribeirão das Neves	331.045	598	17,16	42,06	59,22	9	21	30	17.707	2	2	4	2.575,47
93	MG	Uberaba	330.361	482	17,13	41,97	59,10	9	21	30	14.243	2	2	4	2.071,59
94	MG	Governador Valadares	278.685	894	14,45	35,41	49,85	7	18	25	22.285	2	2	4	3.241,30
95	MG	Ipatinga	261.344	792	13,55	33,20	46,75	7	17	23	18.514	2	2	3	2.692,81
96	MG	Sete Lagoas	237.286	634	12,30	30,15	42,45	6	15	21	13.456	2	1	3	1.957,18
97	MG	Divinópolis	235.977	511	12,23	29,98	42,21	6	15	21	10.786	2	1	3	1.568,77
98	MG	Santa Luzia	218.147	599	11,31	27,72	39,02	6	14	20	11.688	2	1	3	1.699,98
99	MG	Ibirité	179.015	572	9,28	22,74	32,02	5	11	16	9.159	1	1	2	1.332,15
100	MG	Poços de Caldas	166.111	258	8,61	21,10	29,72	4	11	15	3.833	1	1	2	557,55
101	MG	Patos de Minas	150.833	721	7,82	19,16	26,98	4	10	13	9.727	1	1	2	1.414,82
102	MG	Pouso Alegre	148.862	211	7,72	18,91	26,63	4	9	13	2.809	1	1	2	408,63
103	MG	Teófilo Otoni	140.235	1.024	7,27	17,82	25,09	4	9	13	12.845	1	1	2	1.868,21
104	MG	Barbacena	136.392	526	7,07	17,33	24,40	4	9	12	6.417	1	1	2	933,35
105	MG	Sabará	135.421	605	7,02	17,21	24,23	4	9	12	7.328	1	1	2	1.065,88
106	MG	Varginha	134.477	317	6,97	17,09	24,06	3	9	12	3.813	1	1	2	554,59
107	MG	Conselheiro Lafaiete	127.539	592	6,61	16,20	22,82	3	8	11	6.753	1	1	2	982,28
108	MG	Vespasiano	125.376	610	6,50	15,93	22,43	3	8	11	6.841	1	1	2	994,98
109	MG	Itabira	119.186	687	6,18	15,14	21,32	3	8	11	7.324	1	1	2	1.065,25
110	MG	Araguari	116.691	622	6,05	14,83	20,88	3	7	10	6.492	1	1	2	944,27
111	MG	Ubá	114.265	585	5,92	14,52	20,44	3	7	10	5.979	1	1	1	869,64
112	MG	Passos	113.998	385	5,91	14,48	20,39	3	7	10	3.926	1	1	1	570,99
113	MG	Coronel Fabriciano	109.405	777	5,67	13,90	19,57	3	7	10	7.604	1	1	1	1.105,93
114	MG	Muriaé	108.113	628	5,60	13,74	19,34	3	7	10	6.073	1	1	1	883,30
115	MG	Araxá	105.083	568	5,45	13,35	18,80	3	7	9	5.339	1	1	1	776,51
116	MG	Ituiutaba	104.067	691	5,40	13,22	18,62	3	7	9	6.432	1	1	1	935,53
117	MG	Lavras	102.728	380	5,33	13,05	18,38	3	7	9	3.492	1	1	1	507,86
118	MG	Nova Serrana	99.770	552	5,17	12,68	17,85	3	6	9	4.926	1	1	1	716,49
119	MG	Itajubá	96.389	261	5,00	12,25	17,24	2	6	9	2.250	1	1	1	327,29
120	MG	Nova Lima	93.577	603	4,85	11,89	16,74	2	6	8	5.047	1	1	1	734,10
121	MG	Pará de Minas	93.101	572	4,83	11,83	16,66	2	6	8	4.763	1	1	1	692,82
122	MG	Itaúna	92.561	544	4,80	11,76	16,56	2	6	8	4.504	1	1	1	655,08
123	MG	Paracatu	92.430	860	4,79	11,74	16,54	2	6	8	7.110	1	1	1	1.034,14
124	MG	Caratinga	91.503	804	4,74	11,63	16,37	2	6	8	6.580	1	1	1	957,11
125	MG	Patrocínio	90.041	668	4,67	11,44	16,11	2	6	8	5.380	1	1	1	782,50
126	MG	São João del Rei	89.653	470	4,65	11,39	16,04	2	6	8	3.769	1	1	1	548,19
127	MG	Manhuaçu	89.256	758	4,63	11,34	15,97	2	6	8	6.052	1	1	1	880,19
128	MG	Timóteo	89.090	783	4,62	11,32	15,94	2	6	8	6.240	1	1	1	907,53
129	MG	Unaí	83.808	962	4,34	10,65	14,99	2	5	7	7.211	1	0	1	1.048,89
130	MS	Campo Grande	885.711	987	45,92	112,53	158,45	23	56	79	78.193	6	5	12	11.373,07
131	MS	Dourados	220.965	982	11,46	28,07	39,53	6	14	20	19.409	2	1	3	2.822,95
132	MS	Três Lagoas	119.465	668	6,19	15,18	21,37	3	8	11	7.138	1	1	2	1.038,21
133	MS	Corumbá	110.806	1.494	5,74	14,08	19,82	3	7	10	14.807	1	1	1	2.153,69
134	MS	Ponta Porã	91.082	1.102	4,72	11,57	16,29	2	6	8	8.978	1	1	1	1.305,82
135	MT	Cuiabá	607.153	1.529	31,48	77,14	108,61	16	39	54	83.036	4	4	8	12.077,42
136	MT	Várzea Grande	282.009	1.535	14,62	35,83	50,45	7	18	25	38.720	2	2	4	5.631,71
137	MT	Rondonópolis	228.857	1.313	11,86	29,08	40,94	6	15	20	26.878	2	1	3	3.909,29
138	MT	Sinop	139.935	2.007	7,25	17,78	25,03	4	9	13	25.121	1	1	2	3.653,78
139	MT	Tangará da Serra	101.764	1.770	5,28	12,93	18,20	3	6	9	16.111	1	1	1	2.343,34
140	MT	Cáceres	93.882	1.747	4,87	11,93	16,79	2	6	8	14.670	1	1	1	2.133,75
141	MT	Sorriso	87.815	1.924	4,55	11,16	15,71	2	6	8	15.112	1	1	1	2.198,07
142	PA	Belém	1.485.732	2.895	77,02	188,76	265,79	39	94	133	384.725	11	9	19	55.957,41
143	PA	Ananindeua	525.566	2.877	27,25	66,77	94,02	14	33	47	135.247	4	3	7	19.671,42
144	PA	Santarém	302.667	3.295	15,69	38,45	54,14	8	19	27	89.203	2	2	4	12.974,45
145	PA	Marabá	275.086	2.346	14,26	34,95	49,21	7	17	25	57.724	2	2	4	8.395,86
146	PA	Parauapebas	202.882	2.423	10,52	25,78	36,29	5	13	18	43.970	1	1	3	6.395,37
147	PA	Castanhal	198.294	2.837	10,28	25,19	35,47	5	13	18	50.319	1	1	3	7.318,76
148	PA	Abaetetuba	156.292	2.787	8,10	19,86	27,96	4	10	14	38.961	1	1	2	5.666,86
149	PA	Cametá	136.390	2.804	7,07	17,33	24,40	4	9	12	34.208	1	1	2	4.975,41
150	PA	Marituba	129.321	2.889	6,70	16,43	23,13	3	8	12	33.418	1	1	2	4.860,55
151	PA	Bragança	126.436	2.897	6,55	16,06	22,62	3	8	11	32.763	1	1	2	4.765,27
152	PA	São Félix do Xingu	124.763	2.473	6,47	15,85	22,32	3	8	11	27.598	1	1	2	4.014,01
153	PA	Barcarena	122.294	2.818	6,34	15,54	21,88	3	8	11	30.825	1	1	2	4.483,47
154	PA	Altamira	113.195	2.847	5,87	14,38	20,25	3	7	10	28.825	1	1	1	4.192,60
155	PA	Tucuruí	112.148	2.596	5,81	14,25	20,06	3	7	10	26.041	1	1	1	3.787,61
156	PA	Paragominas	111.764	2.619	5,79	14,20	19,99	3	7	10	26.182	1	1	1	3.808,08

157	PA	Tailândia	103.664	2.629	5,37	13,17	18,54	3	7	9	24.377	1	1	1	3.545,58
158	PA	Breves	101.891	2.466	5,28	12,95	18,23	3	6	9	22.475	1	1	1	3.268,87
159	PA	Itaituba	101.097	3.002	5,24	12,84	18,09	3	6	9	27.146	1	1	1	3.948,37
160	PA	Redenção	83.997	2.077	4,35	10,67	15,03	2	5	8	15.605	1	0	1	2.269,70
161	PA	Moju	80.988	2.759	4,20	10,29	14,49	2	5	7	19.986	1	0	1	2.906,97
162	PB	João Pessoa	800.323	2.748	41,49	101,68	143,17	21	51	72	196.718	6	5	10	28.612,16
163	PB	Campina Grande	407.472	2.647	21,12	51,77	72,89	11	26	36	96.475	3	2	5	14.032,02
164	PB	Santa Rita	135.807	2.753	7,04	17,25	24,29	4	9	12	33.442	1	1	2	4.864,04
165	PB	Patos	106.984	2.609	5,55	13,59	19,14	3	7	10	24.966	1	1	1	3.631,29
166	PB	Bayeux	96.550	2.749	5,01	12,27	17,27	3	6	9	23.740	1	1	1	3.452,99
167	PE	Recife	1.637.834	2.636	84,91	208,09	293,00	42	104	146	386.168	12	10	21	56.167,34
168	PE	Jaboatão dos Guararapes	697.636	2.625	36,17	88,63	124,80	18	44	62	163.802	5	4	9	23.824,66
169	PE	Olinda	391.835	2.645	20,31	49,78	70,10	10	25	35	92.702	3	2	5	13.483,34
170	PE	Caruaru	356.872	2.535	18,50	45,34	63,84	9	23	32	80.919	3	2	5	11.769,53
171	PE	Petrolina	343.865	2.206	17,83	43,69	61,51	9	22	31	67.851	2	2	4	9.868,75
172	PE	Paulista	329.117	2.660	17,06	41,81	58,88	9	21	29	78.306	2	2	4	11.389,39
173	PE	Cabo de Santo Agostinho	205.112	2.601	10,63	26,06	36,69	5	13	18	47.719	1	1	3	6.940,65
174	PE	Camaragibe	156.736	2.641	8,13	19,91	28,04	4	10	14	37.025	1	1	2	5.385,25
175	PE	Garanhuns	138.983	2.408	7,21	17,66	24,86	4	9	12	29.935	1	1	2	4.353,98
176	PE	Vitória de Santo Antão	137.915	2.584	7,15	17,52	24,67	4	9	12	31.876	1	1	2	4.636,31
177	PE	Igarassu	115.640	2.6661	6,00	14,69	20,69	3	7	10	17.986.937	1	1	2	2.616.161,07
178	PE	São Lourenço da Mata	112.362	2.635	5,83	14,28	20,10	3	7	10	26.483	1	1	1	3.851,84
179	PE	Santa Cruz do Capibaribe	105.936	2.560	5,49	13,46	18,95	3	7	9	24.257	1	1	1	3.528,19
180	PE	Abreu e Lima	99.622	2.653	5,16	12,66	17,82	3	6	9	23.640	1	1	1	3.438,44
181	PE	Ipojuca	94.709	2.602	4,91	12,03	16,94	2	6	8	22.042	1	1	1	3.206,03
182	PE	Serra Talhada	85.774	2.417	4,45	10,90	15,34	2	5	8	18.544	1	1	1	2.697,12
183	PE	Araripina	83.964	2.647	4,35	10,67	15,02	2	5	8	19.880	1	0	1	2.891,45
184	PE	Gravatá	83.437	2.555	4,33	10,60	14,93	2	5	7	19.068	1	0	1	2.773,44
185	PE	Carpina	82.872	2.639	4,30	10,53	14,83	2	5	7	19.562	1	0	1	2.845,22
186	PI	Teresina	861.442	2.654	44,66	109,45	154,11	22	55	77	204.498	6	5	11	29.743,74
187	PI	Parnaíba	152.653	2.979	7,91	19,39	27,31	4	10	14	40.676	1	1	2	5.916,22
188	PR	Curitiba	1.917.185	408	99,39	243,58	342,97	50	122	171	69.966	14	11	25	10.176,37
189	PR	Londrina	563.943	537	29,24	71,65	100,88	15	36	50	27.088	4	3	7	3.939,84
190	PR	Maringá	417.010	649	21,62	52,98	74,60	11	26	37	24.208	3	2	5	3.520,95
191	PR	Ponta Grossa	348.043	516	18,04	44,22	62,26	9	22	31	16.064	2	2	5	2.336,42
192	PR	Cascavel	324.476	929	16,82	41,22	58,05	8	21	29	26.962	2	2	4	3.921,63
193	PR	São José dos Pinhais	317.476	409	16,46	40,34	56,79	8	20	28	11.614	2	2	4	1.689,28
194	PR	Foz do Iguaçu	258.823	1.058	13,42	32,88	46,30	7	16	23	24.493	2	2	3	3.562,52
195	PR	Colombo	240.840	394	12,49	30,60	43,08	6	15	22	8.488	2	1	3	1.234,51
196	PR	Guarapuava	180.334	670	9,35	22,91	32,26	5	11	16	10.807	1	1	2	1.571,89
197	PR	Paranaguá	153.666	435	7,97	19,52	27,49	4	10	14	5.979	1	1	2	869,63
198	PR	Araucária	141.410	432	7,33	17,97	25,30	4	9	13	5.464	1	1	2	794,75
199	PR	Toledo	138.572	926	7,18	17,61	24,79	4	9	12	11.478	1	1	2	1.669,38
200	PR	Apucarana	133.726	588	6,93	16,99	23,92	3	8	12	7.033	1	1	2	1.022,97
201	PR	Pinhais	130.789	402	6,78	16,62	23,40	3	8	12	4.703	1	1	2	684,02
202	PR	Campo Largo	130.091	525	6,74	16,53	23,27	3	8	12	6.109	1	1	2	888,54
203	PR	Arapongas	121.198	571	6,28	15,40	21,68	3	8	11	6.190	1	1	2	900,33
204	PR	Almirante Tamandaré	117.168	413	6,07	14,89	20,96	3	7	10	4.328	1	1	2	629,55
205	PR	Piraquara	111.052	466	5,76	14,11	19,87	3	7	10	4.629	1	1	1	673,26
206	PR	Umuarama	110.590	810	5,73	14,05	19,78	3	7	10	8.012	1	1	1	1.165,39
207	PR	Cambé	105.704	559	5,48	13,43	18,91	3	7	9	5.285	1	1	1	768,73
208	PR	Fazenda Rio Grande	98.368	433	5,10	12,50	17,60	3	6	9	3.810	1	1	1	554,13
209	PR	Sarandi	95.543	642	4,95	12,14	17,09	2	6	9	5.486	1	1	1	798,00
210	PR	Campo Mourão	94.212	737	4,88	11,97	16,85	2	6	8	6.211	1	1	1	903,32
211	PR	Francisco Beltrão	89.942	885	4,66	11,43	16,09	2	6	8	7.120	1	1	1	1.035,56
212	PR	Paranavaí	87.813	719	4,55	11,16	15,71	2	6	8	5.647	1	1	1	821,40
213	PR	Pato Branco	81.893	853	4,25	10,40	14,65	2	5	7	6.248	1	0	1	908,79
214	PR	Cianorte	81.393	711	4,22	10,34	14,56	2	5	7	5.176	1	0	1	752,88
215	RJ	Rio de Janeiro	6.688.927	444	346,77	849,82	1.196,60	173	425	598	265.644	47	40	87	38.637,41
216	RJ	São Gonçalo	1.077.687	462	55,87	136,92	192,79	28	68	96	44.534	8	6	14	6.477,44
217	RJ	Duque de Caxias	914.383	422	47,40	116,17	163,58	24	58	82	34.515	6	5	12	5.020,06
218	RJ	Nova Iguaçu	818.875	408	42,45	104,04	146,49	21	52	73	29.884	6	5	11	4.346,57
219	RJ	Niterói	511.786	449	26,53	65,02	91,55	13	33	46	20.554	4	3	7	2.989,53
220	RJ	Belford Roxo	508.614	410	26,37	64,62	90,99	13	32	45	18.652	4	3	7	2.712,94
221	RJ	Campos dos Goytacazes	503.424	709	26,10	63,96	90,06	13	32	45	31.926	4	3	7	4.643,53
222	RJ	São João de Meriti	471.888	417	24,46	59,95	84,42	12	30	42	17.601	3	3	6	2.560,02
223	RJ	Petrópolis	305.687	458	15,85	38,84	54,69	8	19	27	12.523	2	2	4	1.821,42
224	RJ	Volta Redonda	271.998	327	14,10	34,56	48,66	7	17	24	7.956	2	2	4	1.157,13
225	RJ	Macaé	251.631	618	13,05	31,97	45,01	7	16	23	13.910	2	1	3	2.023,12
226	RJ	Magé	243.657	454	12,63	30,96	43,59	6	15	22	9.895	2	1	3	1.439,14
227	RJ	Itaboraí	238.695	480	12,37	30,33	42,70	6	15	21	10.248	2	1	3	1.490,57
228	RJ	Cabo Frio	222.528	583	11,54	28,27	39,81	6	14	20	11.604	2	1	3	1.687,80
229	RJ	Angra dos Reis	200.407	405	10,39	25,46	35,85	5	13	18	7.260	1	1	3	1.055,93
230	RJ	Nova Friburgo	190.084	546	9,85	24,15	34,00	5	12	17	9.283	1	1	2	1.350,23
231	RJ	Barra Mansa	183.976	312	9,54	23,37	32,91	5	12	16	5.134	1	1	2	746,77
232	RJ	Teresópolis	180.886	491	9,38	22,98	32,36	5	11	16	7.944	1	1	2	1.155,46
233	RJ	Mesquita	175.620	409	9,10	22,31	31,42	5	11	16	6.425	1	1	2	934,47
234	RJ	Nilópolis	162.269	416	8,41	20,62	29,03	4	10	15	6.038	1	1	2	878,21
235	RJ	Maricá	157.789	489	8,18	20,05	28,23	4	10	14	6.902	1	1	2	1.003,82

236	RJ	Queimados	149.265	395	7,74	18,96	26,70	4	9	13	5.274	1	1	2	767,05
237	RJ	Rio das Ostras	145.989	597	7,57	18,55	26,12	4	9	13	7.796	1	1	2	1.133,87
238	RJ	Araruama	130.439	547	6,76	16,57	23,33	3	8	12	6.382	1	1	2	928,25
239	RJ	Resende	130.334	283	6,76	16,56	23,32	3	8	12	3.299	1	1	2	479,86
240	RJ	Itaguaí	125.913	408	6,53	16,00	22,52	3	8	11	4.595	1	1	2	668,34
241	RJ	Japeri	103.960	387	5,39	13,21	18,60	3	7	9	3.599	1	1	1	523,41
242	RJ	São Pedro da Aldeia	102.846	571	5,33	13,07	18,40	3	7	9	5.253	1	1	1	764,00
243	RJ	Itaperuna	102.626	647	5,32	13,04	18,36	3	7	9	5.939	1	1	1	863,83
244	RJ	Barra do Piraí	99.969	359	5,18	12,70	17,88	3	6	9	3.210	1	1	1	466,90
245	RJ	Saquarema	87.704	542	4,55	11,14	15,69	2	6	8	4.252	1	1	1	618,43
246	RJ	Seropédica	86.743	380	4,50	11,02	15,52	2	6	8	2.948	1	1	1	428,83
247	RJ	Três Rios	81.453	443	4,22	10,35	14,57	2	5	7	3.228	1	0	1	469,44
248	RN	Natal	877.640	3.075	45,50	111,50	157,00	23	56	79	241.392	6	5	11	35.109,94
249	RN	Mossoró	294.076	2.766	15,25	37,36	52,61	8	19	26	72.757	2	2	4	10.582,31
250	RN	Parnamirim	255.793	3.055	13,26	32,50	45,76	7	16	23	69.897	2	2	3	10.166,43
251	RN	São Gonçalo do Amarante	101.102	3.079	5,24	12,84	18,09	3	6	9	27.844	1	1	1	4.049,84
252	RO	Porto Velho	519.531	2.987	26,93	66,01	92,94	13	33	46	138.806	4	3	7	20.189,02
253	RO	Ji-Paraná	127.907	2.616	6,63	16,25	22,88	3	8	11	29.929	1	1	2	4.353,12
254	RO	Ariquemes	106.168	2.791	5,50	13,49	18,99	3	7	9	26.504	1	1	1	3.854,98
255	RO	Vilhena	97.448	2.283	5,05	12,38	17,43	3	6	9	19.899	1	1	1	2.894,33
256	RO	Cacoal	84.813	2.509	4,40	10,78	15,17	2	5	8	19.034	1	1	1	2.768,42
257	RR	Boa Vista	375.374	4.657	19,46	47,69	67,15	10	24	34	156.362	3	2	5	22.742,54
258	RS	Porto Alegre	1.479.101	1.130	76,68	187,92	264,60	38	94	132	149.499	10	9	19	21.744,27
259	RS	Caxias do Sul	504.069	977	26,13	64,04	90,17	13	32	45	44.050	4	3	7	6.406,98
260	RS	Canoas	344.957	1.128	17,88	43,83	61,71	9	22	31	34.804	2	2	4	5.062,24
261	RS	Pelotas	341.648	1.380	17,71	43,41	61,12	9	22	31	42.172	2	2	4	6.133,76
262	RS	Santa Maria	280.505	1.258	14,54	35,64	50,18	7	18	25	31.563	2	2	4	4.590,82
263	RS	Gravataí	279.398	1.105	14,48	35,50	49,98	7	18	25	27.615	2	2	4	4.016,56
264	RS	Viamão	254.101	1.128	13,17	32,28	45,46	7	16	23	25.638	2	2	3	3.728,93
265	RS	Novo Hamburgo	246.452	1.143	12,78	31,31	44,09	6	16	22	25.196	2	1	3	3.664,77
266	RS	São Leopoldo	234.947	1.134	12,18	29,85	42,03	6	15	21	23.831	2	1	3	3.466,18
267	RS	Rio Grande	210.005	1.352	10,89	26,68	37,57	5	13	19	25.396	1	1	3	3.693,81
268	RS	Alvorada	209.213	1.120	10,85	26,58	37,43	5	13	19	20.959	1	1	3	3.048,42
269	RS	Passo Fundo	201.767	957	10,46	25,63	36,09	5	13	18	17.271	1	1	3	2.512,06
270	RS	Sapucaia do Sul	140.311	1.124	7,27	17,83	25,10	4	9	13	14.107	1	1	2	2.051,76
271	RS	Santa Cruz do Sul	129.427	1.271	6,71	16,44	23,15	3	8	12	14.714	1	1	2	2.140,12
272	RS	Cachoeirinha	129.307	1.113	6,70	16,43	23,13	3	8	12	12.873	1	1	2	1.872,34
273	RS	Uruguaiana	127.079	1.570	6,59	16,15	22,73	3	8	11	17.846	1	1	2	2.595,63
274	RS	Bagé	120.943	1.496	6,27	15,37	21,64	3	8	11	16.184	1	1	2	2.353,86
275	RS	Bento Gonçalves	119.049	1.017	6,17	15,13	21,30	3	8	11	10.829	1	1	2	1.575,13
276	RS	Erechim	105.059	877	5,45	13,35	18,79	3	7	9	8.241	1	1	1	1.198,67
277	RS	Guaíba	98.043	1.149	5,08	12,46	17,54	3	6	9	10.076	1	1	1	1.465,57
278	RS	Ijuí	83.173	1.122	4,31	10,57	14,88	2	5	7	8.347	1	0	1	1.214,07
279	RS	Esteio	83.121	1.128	4,31	10,56	14,87	2	5	7	8.387	1	0	1	1.219,80
280	RS	Lajeado	82.951	1.077	4,30	10,54	14,84	2	5	7	7.991	1	0	1	1.162,27
281	RS	Cachoeira do Sul	82.547	1.319	4,28	10,49	14,77	2	5	7	9.739	1	0	1	1.416,49
282	RS	Sapiranga	81.198	1.125	4,21	10,32	14,53	2	5	7	8.171	1	0	1	1.188,41
283	SC	Joinville	583.144	583	30,23	74,09	104,32	15	37	52	30.409	4	3	8	4.422,96
284	SC	Florianópolis	492.977	758	25,56	62,63	88,19	13	31	44	33.424	3	3	6	4.861,43
285	SC	Blumenau	352.460	637	18,27	44,78	63,05	9	22	32	20.082	2	2	5	2.920,91
286	SC	São José	242.927	746	12,59	30,86	43,46	6	15	22	16.210	2	1	3	2.357,67
287	SC	Chapecó	216.654	879	11,23	27,53	38,76	6	14	19	17.034	2	1	3	2.477,56
288	SC	Itajaí	215.895	662	11,19	27,43	38,62	6	14	19	12.784	2	1	3	1.859,38
289	SC	Criciúma	213.023	938	11,04	27,06	38,11	6	14	19	17.873	2	1	3	2.599,55
290	SC	Jaraguá do Sul	174.158	571	9,03	22,13	31,16	5	11	16	8.895	1	1	2	1.293,74
291	SC	Palhoça	168.259	755	8,72	21,38	30,10	4	11	15	11.363	1	1	2	1.652,70
292	SC	Lages	157.743	765	8,18	20,04	28,22	4	10	14	10.794	1	1	2	1.569,93
293	SC	Balneário Camboriú	138.732	675	7,19	17,63	24,82	4	9	12	8.376	1	1	2	1.218,29
294	SC	Brusque	131.703	694	6,83	16,73	23,56	3	8	12	8.176	1	1	2	1.189,11
295	SC	Tubarão	104.937	874	5,44	13,33	18,77	3	7	9	8.204	1	1	1	1.193,19
296	SC	São Bento do Sul	83.576	511	4,33	10,62	14,95	2	5	7	3.820	1	0	1	555,61
297	SC	Camboriú	80.834	675	4,19	10,27	14,46	2	5	7	4.880	1	0	1	709,85
298	SE	Aracaju	648.939	2.155	33,64	82,45	116,09	17	41	58	125.087	5	4	8	18.193,64
299	SE	Nossa Senhora do Socorro	181.503	2.153	9,41	23,06	32,47	5	12	16	34.953	1	1	2	5.083,89
300	SE	Lagarto	103.576	2.119	5,37	13,16	18,53	3	7	9	19.631	1	1	1	2.855,35
301	SE	Itabaiana	94.696	2.158	4,91	12,03	16,94	2	6	8	18.279	1	1	1	2.658,59
302	SE	São Cristóvão	89.027	2.143	4,62	11,31	15,93	2	6	8	17.065	1	1	1	2.482,06
303	SP	São Paulo	12.176.866	0	631,28	1547,06	2.178,35	316	774	1.089	0	86	72	158	0,00
304	SP	Guarulhos	1.365.899	20	70,81	173,54	244,35	35	87	122	2.443	10	8	18	355,40
305	SP	Campinas	1.194.094	99	61,91	151,71	213,61	31	76	107	10.574	8	7	16	1.537,95
306	SP	São Bernardo do Campo	833.240	22,7	43,20	105,86	149,06	22	53	75	1.692	6	5	11	246,07
307	SP	Santo André	716.109	23,7	37,13	90,98	128,11	19	45	64	1.518	5	4	9	220,80
308	SP	São José dos Campos	713.943	97,4	37,01	90,71	127,72	19	45	64	6.220	5	4	9	904,67
309	SP	Osasco	696.850	23,4	36,13	88,53	124,66	18	44	62	1.459	5	4	9	212,14
310	SP	Ribeirão Preto	694.534	316	36,01	88,24	124,25	18	44	62	19.631	5	4	9	2.855,28
311	SP	Sorocaba	671.186	104	34,80	85,27	120,07	17	43	60	6.244	5	4	9	908,12
312	SP	Mauá	468.148	27,1	24,27	59,48	83,75	12	30	42	1.135	3	3	6	165,05
313	SP	São José do Rio Preto	456.245	440	23,65	57,97	81,62	12	29	41	17.956	3	3	6	2.611,68
314	SP	Mogi das Cruzes	440.769	63,7	22,85	56,00	78,85	11	28	39	2.511	3	3	6	365,27

315	SP	Santos	432.957	81,2	22,45	55,01	77,45	11	28	39	3.145	3	3	6	457,37
316	SP	Diadema	420.934	22,6	21,82	53,48	75,30	11	27	38	851	3	2	5	123,76
317	SP	Jundiaí	414.810	58,8	21,50	52,70	74,21	11	26	37	2.182	3	2	5	317,32
318	SP	Piracicaba	400.949	157	20,79	50,94	71,73	10	25	36	5.631	3	2	5	818,95
319	SP	Carapicuíba	398.611	30	20,67	50,64	71,31	10	25	36	1.070	3	2	5	155,57
320	SP	Bauru	374.272	332	19,40	47,55	66,95	10	24	33	11.114	3	2	5	1.616,57
321	SP	Itaquaquecetuba	366.519	43,5	19,00	46,57	65,57	10	23	33	1.426	3	2	5	207,42
322	SP	São Vicente	363.173	73	18,83	46,14	64,97	9	23	32	2.371	3	2	5	344,91
323	SP	Franca	350.400	400	18,17	44,52	62,68	9	22	31	12.537	2	2	5	1.823,44
324	SP	Praia Grande	319.146	77,6	16,55	40,55	57,09	8	20	29	2.215	2	2	4	322,20
325	SP	Guarujá	318.107	98,9	16,49	40,42	56,91	8	20	28	2.814	2	2	4	409,30
326	SP	Taubaté	311.854	140	16,17	39,62	55,79	8	20	28	3.905	2	2	4	568,00
327	SP	Limeira	303.682	163	15,74	38,58	54,33	8	19	27	4.428	2	2	4	643,98
328	SP	Suzano	294.638	51,7	15,27	37,43	52,71	8	19	26	1.363	2	2	4	198,17
329	SP	Taboão da Serra	285.570	18,9	14,80	36,28	51,09	7	18	26	483	2	2	4	70,22
330	SP	Sumaré	278.571	119	14,44	35,39	49,83	7	18	25	2.965	2	2	4	431,27
331	SP	Barueri	271.306	31,7	14,07	34,47	48,53	7	17	24	769	2	2	4	111,89
332	SP	Embu das Artes	270.843	31,1	14,04	34,41	48,45	7	17	24	753	2	2	4	109,58
333	SP	São Carlos	249.415	234	12,93	31,69	44,62	6	16	22	5.220	2	1	3	759,29
334	SP	Indaiatuba	246.908	103	12,80	31,37	44,17	6	16	22	2.275	2	1	3	330,86
335	SP	Cotia	244.694	34	12,69	31,09	43,77	6	16	22	744	2	1	3	108,24
336	SP	Marília	237.130	437	12,29	30,13	42,42	6	15	21	9.269	2	1	3	1.348,14
337	SP	Americana	237.112	129	12,29	30,12	42,42	6	15	21	2.736	2	1	3	397,93
338	SP	Itapevi	234.352	42,6	12,15	29,77	41,92	6	15	21	893	2	1	3	129,88
339	SP	Araraquara	233.744	277	12,12	29,70	41,81	6	15	21	5.791	2	1	3	842,34
340	SP	Jacareí	231.863	89,9	12,02	29,46	41,48	6	15	21	1.864	2	1	3	271,18
341	SP	Hortolândia	227.353	115	11,79	28,89	40,67	6	14	20	2.339	2	1	3	340,15
342	SP	Presidente Prudente	227.072	558	11,77	28,85	40,62	6	14	20	11.333	2	1	3	1.648,41
343	SP	Rio Claro	204.797	188	10,62	26,02	36,64	5	13	18	3.444	1	1	3	500,90
344	SP	Araçatuba	195.874	522	10,15	24,89	35,04	5	12	18	9.146	1	1	3	1.330,20
345	SP	Santa Bárbara d'Oeste	192.536	139	9,98	24,46	34,44	5	12	17	2.394	1	1	3	348,17
346	SP	Ferraz de Vasconcelos	191.993	32	9,95	24,39	34,35	5	12	17	550	1	1	2	79,93
347	SP	Francisco Morato	174.008	47,7	9,02	22,11	31,13	5	11	16	742	1	1	2	107,98
348	SP	Itapecerica da Serra	173.672	36,7	9,00	22,06	31,07	5	11	16	570	1	1	2	82,92
349	SP	Itu	172.268	103	8,93	21,89	30,82	4	11	15	1.587	1	1	2	230,84
350	SP	Bragança Paulista	166.753	87,5	8,64	21,19	29,83	4	11	15	1.305	1	1	2	189,82
351	SP	Pindamonhangaba	166.475	157	8,63	21,15	29,78	4	11	15	2.338	1	1	2	340,03
352	SP	Itapetininga	162.231	180	8,41	20,61	29,02	4	10	15	2.612	1	1	2	379,90
353	SP	São Caetano do Sul	160.275	12,7	8,31	20,36	28,67	4	10	14	182	1	1	2	26,48
354	SP	Franco da Rocha	152.433	43,3	7,90	19,37	27,27	4	10	14	590	1	1	2	85,87
355	SP	Mogi Guaçu	150.713	162	7,81	19,15	26,96	4	10	13	2.184	1	1	2	317,64
356	SP	Jaú	148.581	299	7,70	18,88	26,58	4	9	13	3.974	1	1	2	577,97
357	SP	Botucatu	144.820	238	7,51	18,40	25,91	4	9	13	3.083	1	1	2	448,41
358	SP	Atibaia	141.398	67,7	7,33	17,96	25,29	4	9	13	856	1	1	2	124,54
359	SP	Santana de Parnaíba	136.517	41,5	7,08	17,34	24,42	4	9	12	507	1	1	2	73,71
360	SP	Araras	132.934	172	6,89	16,89	23,78	3	8	12	2.045	1	1	2	297,46
361	SP	Cubatão	129.760	70,7	6,73	16,49	23,21	3	8	12	821	1	1	2	119,35
362	SP	Valinhos	127.123	91,8	6,59	16,15	22,74	3	8	11	1.044	1	1	2	151,82
363	SP	Sertãozinho	124.453	336	6,45	15,81	22,26	3	8	11	3.740	1	1	2	544,02
364	SP	Jandira	123.481	38	6,40	15,69	22,09	3	8	11	420	1	1	2	61,05
365	SP	Ribeirão Pires	122.607	49,5	6,36	15,58	21,93	3	8	11	543	1	1	2	78,96
366	SP	Birigui	122.359	514	6,34	15,55	21,89	3	8	11	5.625	1	1	2	818,22
367	SP	Barretos	121.344	423	6,29	15,42	21,71	3	8	11	4.591	1	1	2	667,77
368	SP	Votorantim	121.331	105	6,29	15,42	21,71	3	8	11	1.140	1	1	2	165,74
369	SP	Catanduva	121.210	386	6,28	15,40	21,68	3	8	11	4.185	1	1	2	608,69
370	SP	Guaratinguetá	121.073	188	6,28	15,38	21,66	3	8	11	2.036	1	1	2	296,12
371	SP	Várzea Paulista	120.572	59,4	6,25	15,32	21,57	3	8	11	641	1	1	2	93,18
372	SP	Tatuí	120.533	143	6,25	15,31	21,56	3	8	11	1.542	1	1	2	224,24
373	SP	Caraguatatuba	119.625	181	6,20	15,20	21,40	3	8	11	1.937	1	1	2	281,69
374	SP	Itatiba	119.090	83,6	6,17	15,13	21,30	3	8	11	891	1	1	2	129,52
375	SP	Salto	117.561	103	6,09	14,94	21,03	3	7	11	1.083	1	1	2	157,53
376	SP	Poá	116.530	47,7	6,04	14,81	20,85	3	7	10	497	1	1	2	72,31
377	SP	Ourinhos	112.711	373	5,84	14,32	20,16	3	7	10	3.760	1	1	1	546,95
378	SP	Paulínia	106.776	122	5,54	13,57	19,10	3	7	10	1.165	1	1	1	169,47
379	SP	Assis	103.666	438	5,37	13,17	18,55	3	7	9	4.061	1	1	1	590,72
380	SP	Leme	102.412	189	5,31	13,01	18,32	3	7	9	1.731	1	1	1	251,81
381	SP	Itanhaém	100.496	115	5,21	12,77	17,98	3	6	9	1.034	1	1	1	150,35
382	SP	Caieiras	100.129	36,7	5,19	12,72	17,91	3	6	9	329	1	1	1	47,81
383	SP	Mairiporã	98.374	38	5,10	12,50	17,60	3	6	9	334	1	1	1	48,63
384	SP	Itapeva	93.892	292	4,87	11,93	16,80	2	6	8	2.452	1	1	1	356,68
385	SP	Votuporanga	93.736	521	4,86	11,91	16,77	2	6	8	4.368	1	1	1	635,35
386	SP	Caçapava	93.488	114	4,85	11,88	16,72	2	6	8	953	1	1	1	138,65
387	SP	Mogi Mirim	92.715	153	4,81	11,78	16,59	2	6	8	1.269	1	1	1	184,55
388	SP	São João da Boa Vista	90.637	217	4,70	11,52	16,21	2	6	8	1.759	1	1	1	255,88
389	SP	Avaré	90.063	267	4,67	11,44	16,11	2	6	8	2.151	1	1	1	312,84
390	SP	São Roque	89.943	69,9	4,66	11,43	16,09	2	6	8	562	1	1	1	81,79
391	SP	Ubatuba	89.747	225	4,65	11,40	16,06	2	6	8	1.806	1	1	1	262,71
392	SP	Arujá	88.455	51,8	4,59	11,24	15,82	2	6	8	410	1	1	1	59,61
393	SP	Lorena	88.276	200	4,58	11,22	15,79	2	6	8	1.579	1	1	1	229,69
394	SP	São Sebastião	87.596	204	4,54	11,13	15,67	2	6	8	1.598	1	1	1	232,48
395	SP	Campo Limpo Paulista	83.735	63,3	4,34	10,64	14,98	2	5	7	474	1	0	1	68,96

396	SP	Matão	82.702	306		4,29	10,51	14,79	2	5	7	2.264	1	0	1	329,23
397	SP	Cruzeiro	81.895	227		4,25	10,40	14,65	2	5	7	1.663	1	0	1	241,85
398	TO	Palmas	291.855	1.814		15,13	37,08	52,21	8	19	26	47.355	2	2	4	6.887,68
399	TO	Araguaína	177.517	2.070		9,20	22,55	31,76	5	11	16	32.868	1	1	2	4.780,56
400	TO	Gurupi	85.737	1.528		4,44	10,89	15,34	2	5	8	11.718	1	1	1	1.704,36
			126.305.149			6.548	16047	22.595	3.274	8.024	11.298	30.278.290,7	894	749	1.643	4.403.912

		Without RL				With RL			
Impact category	Unity	Sc1	Sc2	Sc3	Sc4	Sc1 - RL	Sc2 - RL	Sc3 - RL	Sc4 - RL
Climate change	kg CO2 eq	2.16E+06	2.36E+06	2.37E+06	2.33E+06	2.19E+06	2.68E+06	2.62E+06	3.08E+06
Ozone depletion	kg CFC-11 eq	3.00E-02	1.00E-01	1.00E-01	2.30E-01	3.56E-02	1.47E-01	1.34E-01	3.52E-01
Human Toxicity - non cancer	CTUh	4.45E+00	4.35E+00	4.32E+00	2.71E+00	4.46E+00	4.42E+00	4.38E+00	2.87E+00
Human Toxicity - cancer effects	CTUh	7.00E-02	8.00E-02	8.00E-02	8.00E-02	8.10E-02	9.02E-02	8.78E-02	1.14E-01
Particulate matter	kg PM2.5 eq	2.40E+02	2.29E+03	5.36E+03	4.39E+04	2.55E+02	2.44E+03	5.47E+03	4.42E+04
Ionizing radiation HH	kBq U235 eq	1.84E+04	5.08E+04	5.23E+04	1.14E+05	2.06E+04	7.34E+04	6.96E+04	1.66E+05
Ionizing radiation E (interim)	CTUe	7.00E-02	1.80E-01	1.80E-01	3.90E-01	8.44E-02	3.35E-01	3.01E-01	7.26E-01
Photochemical ozone formation	kg NMVOC eq	1.32E+03	2.24E+03	2.35E+03	4.69E+03	1.49E+03	3.96E+03	3.67E+03	8.68E+03
Acidification	molc H+ eq	1.19E+03	3.37E+03	4.24E+03	1.73E+04	1.35E+03	5.04E+03	5.52E+03	2.12E+04
Terrestrial eutrophication	molc N eq	2.62E+03	6.41E+03	7.25E+03	2.19E+04	3.23E+03	1.25E+04	1.20E+04	3.62E+04
Freshwater eutrophication	kg P eq	9.18E+01	1.96E+02	1.99E+02	3.76E+02	9.45E+01	2.24E+02	2.21E+02	4.40E+02
Marine eutrophication	kg N eq	5.38E+03	5.61E+03	5.65E+03	5.20E+03	5.43E+03	6.17E+03	6.08E+03	6.50E+03
Freshwater ecotoxicity	CTUe	3.29E+08	3.20E+08	3.18E+08	2.04E+08	3.30E+08	3.22E+08	3.20E+08	2.10E+08
Land Use	kg C deficit	9.01E+04	1.69E+05	2.28E+05	1.01E+06	2.14E+05	1.41E+06	1.18E+06	3.91E+06
Water resource depletion	m3 water eq	6.32E+00	2.31E+02	5.32E+02	4.34E+03	7.07E+01	8.81E+02	1.03E+03	5.85E+03
Mineral, fossil & ren resource depletion	kg Sb eq	2.00E+00	7.08E+00	8.60E+00	3.33E+01	2.01E+00	7.14E+00	8.64E+00	3.34E+01

	Results without RL					Scenarios classification without RL	
Impact category	Unity	Sc1	Sc2	Sc3	Sc4	Best scenario	Worst scenario
Climate change	kg CO2 eq	2.00E+06	1.79E+06	1.69E+06	-1.83E+05	4	1
Ozone depletion	kg CFC-11 eq	2.00E-02	7.00E-02	6.00E-02	6.00E-02	1	2
Human Toxicity - non cancer	CTUh	2.89E+00	-6.00E-01	-5.50E-01	-6.06E+00	4	1
Human Toxicity - cancer effects	CTUh	2.00E-02	-1.40E-01	-2.30E-01	-1.56E+00	4	1
Particulate matter	kg PM2.5 eq	-7.15E+02	-8.90E+02	1.93E+03	3.45E+04	2	4
Ionizing radiation HH	kBq U235 eq	8.33E+03	1.32E+04	4.61E+03	-9.01E+04	4	2
Ionizing radiation E (interim)	CTUe	3.00E-02	3.00E-02	-1.00E-02	-4.00E-01	4	2
Photochemical ozone formation	kg NMVOC eq	-1.17E+03	-6.43E+03	-7.61E+03	-2.89E+04	4	1
Acidification	molc H+ eq	-1.57E+04	-5.29E+04	-5.60E+04	-1.44E+05	4	1
Terrestrial eutrophication	molc N eq	-5.23E+03	-2.17E+04	-2.64E+04	-1.05E+05	4	1
Freshwater eutrophication	kg P eq	-4.95E+02	-1.69E+03	-1.71E+03	-3.56E+03	4	1
Marine eutrophication	kg N eq	4.82E+03	3.62E+03	3.26E+03	-3.81E+03	4	1
Freshwater ecotoxicity	CTUe	1.79E+08	-1.59E+08	-1.58E+08	-6.96E+08	4	1
Land Use	kg C deficit	-4.21E+05	-1.72E+06	-2.13E+06	-8.74E+06	4	1
Water resource depletion	m3 water eq	-1.44E+02	-3.09E+02	-1.22E+02	1.82E+03	2	4
Mineral, fossil & ren resource depletion	kg Sb eq	-2.52E+02	-9.79E+02	-1.31E+03	-6.14E+03	4	1

	Results with RL				Scenarios classification with RL	
Impact category	Sc1 - RL	Sc2 - RL	Sc3 - RL	Sc4 - RL	Best scenario	Worst scenario
Climate change	2.03E+06	2.12E+06	1.94E+06	5.66E+05	4	2
Ozone depletion	2.56E-02	1.17E-01	9.36E-02	1.92E-01	1	4
Human Toxicity - non cancer	2.90E+00	-5.16E-01	-4.93E-01	-5.90E+00	4	1
Human Toxicity - cancer effects	3.10E-02	-1.30E-01	-2.22E-01	-1.52E+00	4	1
Particulate matter	-7.00E+02	-7.39E+02	2.05E+03	3.48E+04	2	4
Ionizing radiation HH	1.06E+04	3.58E+04	2.19E+04	-3.77E+04	4	2
Ionizing radiation E (interim)	4.44E-02	1.95E-01	1.11E-01	-6.39E-02	4	2
Photochemical ozone formation	-1.00E+03	-4.71E+03	-6.29E+03	-2.49E+04	4	1
Acidification	-1.56E+04	-5.12E+04	-5.47E+04	-1.41E+05	4	1
Terrestrial eutrophication	-4.62E+03	-1.55E+04	-2.17E+04	-9.05E+04	4	1
Freshwater eutrophication	-4.92E+02	-1.66E+03	-1.69E+03	-3.50E+03	4	1
Marine eutrophication	4.88E+03	4.18E+03	3.69E+03	-2.51E+03	4	1
Freshwater ecotoxicity	1.80E+08	-1.56E+08	-1.56E+08	-6.90E+08	4	1
Land Use	-2.97E+05	-4.69E+05	-1.17E+06	-5.84E+06	4	1
Water resource depletion	-7.92E+01	3.41E+02	3.76E+02	3.33E+03	1	4
Mineral, fossil & ren resource depletion	-2.52E+02	-9.79E+02	-1.31E+03	-6.14E+03	4	1

Scenario 1 (2023)

Impact category	Unity	External recycling (90 t)	Intermediary transport (18000 tkm)	Sea transport (842.490 tkm)	Landfill (2.925 t)	Total of impacts	Avoided impact of external recycling	Net impact scenario 1	Transport RL Brazil - 188.120 tkm	Total with RL Brazil	Total avoided impact	Net impact with RL	Increase (%)	% transport of total
Climate change	kg CO2 eq	1.12E+05	3.19E+03	5.07E+03	2.04E+06	2.16E+06	-1.60E+05	2.00E+06	3.20E+04	2.19E+06	-1.60E+05	2.03E+06	1.48%	1.46%
Ozone depletion	kg CFC-11 eq	3.00E-02	0.00E+00	0.00E+00	0.00E+00	3.00E-02	-1.00E-02	2.00E-02	5.64E-03	3.56E-02	-1.00E-02	2.56E-02	18.79%	15.82%
Human Toxicity - non cancer	CTUh	4.00E-02	0.00E+00	0.00E+00	4.41E+00	4.45E+00	-1.56E+00	2.89E+00	7.32E-03	4.46E+00	-1.56E+00	2.90E+00	0.16%	0.16%
Human Toxicity - cancer effects	CTUh	1.00E-02	0.00E+00	0.00E+00	7.00E-02	7.00E-02	-5.00E-02	2.00E-02	1.01E-03	8.10E-02	-5.00E-02	3.10E-02	15.73%	1.25%
Particulate matter	kg PM2.5 eq	1.87E+02	9.80E-01	5.78E+00	4.59E+01	2.40E+02	-9.55E+02	-7.15E+02	1.50E+01	2.55E+02	-9.55E+02	-7.00E+02	6.24%	5.88%
Ionizing radiation HH	kBq U235 eq	1.39E+04	1.96E+02	2.90E+02	4.01E+03	1.84E+04	-1.01E+04	8.33E+03	2.24E+03	2.06E+04	-1.01E+04	1.06E+04	12.17%	10.85%
Ionizing radiation E (interim)	CTUe	5.00E-02	0.00E+00	0.00E+00	2.00E-02	7.00E-02	-4.00E-02	3.00E-02	1.44E-02	8.44E-02	-4.00E-02	4.44E-02	20.51%	17.02%
Photochemical ozone formation	kg NMVOC eq	2.91E+02	1.46E+01	1.02E+02	9.16E+02	1.32E+03	-2.50E+03	-1.17E+03	1.71E+02	1.49E+03	-2.50E+03	-1.00E+03	12.88%	11.41%
Acidification	molc H+ eq	6.15E+02	1.44E+01	1.58E+02	3.99E+02	1.19E+03	-1.69E+04	-1.57E+04	1.66E+02	1.35E+03	-1.69E+04	-1.56E+04	13.97%	12.26%
Terrestrial eutrophication	molc N eq	1.08E+03	5.71E+01	3.97E+02	1.09E+03	2.62E+03	-7.85E+03	-5.23E+03	6.10E+02	3.23E+03	-7.85E+03	-4.62E+03	23.23%	18.85%
Freshwater eutrophication	kg P eq	4.73E+01	6.00E-02	3.00E-02	4.44E+01	9.18E+01	-5.87E+02	-4.95E+02	2.76E+00	9.45E+01	-5.87E+02	-4.92E+02	3.00%	2.92%
Marine eutrophication	kg N eq	1.38E+02	5.19E+00	3.56E+01	5.20E+03	5.38E+03	-5.56E+02	4.82E+03	5.58E+01	5.43E+03	-5.56E+02	4.88E+03	1.04%	1.03%
Freshwater ecotoxicity	CTUe	1.35E+06	8.62E+03	1.19E+03	3.28E+08	3.29E+08	-1.50E+08	1.79E+08	2.67E+05	3.30E+08	-1.50E+08	1.80E+08	0.08%	0.08%
Land Use	kg C deficit	2.22E+04	8.17E+01	3.31E+01	6.78E+04	9.01E+04	-5.11E+05	-4.21E+05	1.24E+05	2.14E+05	-5.11E+05	-2.97E+05	137.23%	57.85%
Water resource depletion	m3 water eq	2.81E+01	1.02E+00	3.00E-01	-2.31E+01	6.32E+00	-1.50E+02	-1.44E+02	6.44E+01	7.07E+01	-1.50E+02	-7.92E+01	1019.10%	91.06%
Mineral, fossil & ren resource depletion	kg Sb eq	1.94E+00	0.00E+00	0.00E+00	6.00E-02	2.00E+00	-2.54E+02	-2.52E+02	6.71E-03	2.01E+00	-2.54E+02	-2.52E+02	0.34%	0.33%

Scenario 2 (2024)

Impact category	Unity	External recycling (282 t)	Brazil recycling (47,1 t)	Intermediary transport (56.400 tkm)	Sea transport (2.639.7 tkm)	Landfill (2.809 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact scenario 2	Transport LR Brazil - 1.896.095 tkm	Total with LR brazil	Total avoided impact	Net impact with RL	Increase (%)	% transport of total
Climate change	kg CO2 eq	3.51E+05	2.40E+04	1.00E+04	1.59E+04	1.96E+06	2.36E+06	-5.00E+05	-6.81E+04	1.79E+06	3.23E+05	2.68E+06	-5.68E+05	2.12E+06	13.67%	12.03%
Ozone depletion	kg CFC-11 eq	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-01	-3.00E-02	0.00E+00	7.00E-02	5.68E-02	1.47E-01	-3.00E-02	1.17E-01	46.82%	38.70%
Human Toxicity - non cancer	CTUh	1.20E-01	0.00E+00	0.00E+00	0.00E+00	4.23E+00	4.35E+00	-4.88E+00	-6.00E-02	-6.00E-01	7.38E-02	4.42E+00	-4.94E+00	-5.16E-01	1.70%	1.67%
Human Toxicity - cancer effects	CTUh	2.00E-02	0.00E+00	0.00E+00	0.00E+00	6.00E-02	8.00E-02	-1.70E-01	-5.00E-02	-1.40E-01	1.02E-02	9.02E-02	-2.20E-01	-1.30E-01	12.76%	11.31%
Particulate matter	kg PM2.5 eq	5.87E+02	1.64E+03	3.07E+00	1.81E+01	4.40E+01	2.29E+03	-2.99E+03	-1.92E+02	-8.90E+02	1.51E+02	2.44E+03	-3.18E+03	-7.39E+02	6.57%	6.17%
Ionizing radiation HH	kBq U235 eq	4.37E+04	1.74E+03	6.15E+02	9.09E+02	3.85E+03	5.08E+04	-3.15E+04	-6.03E+03	1.32E+04	2.26E+04	7.34E+04	-3.76E+04	3.58E+04	44.39%	30.74%
Ionizing radiation E (interim)	CTUe	1.50E-01	1.00E-02	0.00E+00	1.00E-02	2.00E-02	1.80E-01	-1.20E-01	-2.00E-02	3.00E-02	1.45E-01	3.35E-01	-1.40E-01	1.95E-01	85.96%	43.24%
Photochemical ozone formation	kg NMVOC eq	9.11E+02	8.85E+01	4.59E+01	3.19E+02	8.80E+02	2.24E+03	-7.82E+03	-8.49E+02	-6.43E+03	1.72E+03	3.96E+03	-8.67E+03	-4.71E+03	76.58%	43.37%
Acidification	molc H+ eq	1.93E+03	5.16E+02	4.51E+01	4.96E+02	3.83E+02	3.37E+03	-5.30E+04	-3.23E+03	-5.29E+04	1.67E+03	5.04E+03	-5.63E+04	-5.12E+04	49.57%	33.14%
Terrestrial eutrophication	molc N eq	3.40E+03	5.47E+02	1.79E+02	1.24E+03	1.04E+03	6.41E+03	-2.46E+04	-3.47E+03	-2.17E+04	6.14E+03	1.25E+04	-2.81E+04	-1.55E+04	95.90%	48.95%
Freshwater eutrophication	kg P eq	1.48E+02	5.14E+00	2.00E-01	1.00E-01	4.26E+01	1.96E+02	-1.84E+03	-4.81E+01	-1.69E+03	2.78E+01	2.24E+02	-1.89E+03	-1.66E+03	14.19%	12.42%
Marine eutrophication	kg N eq	4.32E+02	5.58E+01	1.63E+01	1.12E+02	4.99E+03	5.61E+03	-1.74E+03	-2.47E+02	3.62E+03	5.62E+02	6.17E+03	-1.99E+03	4.18E+03	10.03%	9.12%
Freshwater ecotoxicity	CTUe	4.23E+06	5.28E+05	2.70E+04	3.71E+03	3.15E+08	3.20E+08	-4.70E+08	-8.21E+06	-1.59E+08	2.69E+06	3.22E+08	-4.78E+08	-1.56E+08	0.84%	0.83%
Land Use	kg C deficit	6.97E+04	3.34E+04	2.56E+02	1.04E+02	6.51E+04	1.69E+05	-1.60E+06	-2.83E+05	-1.72E+06	1.25E+06	1.41E+06	-1.88E+06	-4.69E+05	739.61%	88.09%
Water resource depletion	m3 water eq	8.81E+01	1.61E+02	3.18E+00	9.50E-01	-2.22E+01	2.31E+02	-4.70E+02	-7.02E+01	-3.09E+02	6.49E+02	8.81E+02	-5.40E+02	3.41E+02	280.48%	73.72%
Mineral, fossil & ren resource depletion	kg Sb eq	6.08E+00	9.30E-01	1.00E-02	0.00E+00	5.00E-02	7.08E+00	-7.95E+02	-1.92E+02	-9.79E+02	6.76E-02	7.14E+00	-9.86E+02	-9.79E+02	0.81%	0.95%

Scenario 3 (2025)

Impact category	Unity	External recycling (271 t)	Brazil recycling (135,7 t)	Intermediary transport(54.200 tkm)	Sea transport (2.536.8 tkm)	Landfill (2.786 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact scenario 3	Transport LR Brazil - 1.454.946 tkm	Total with LR brazil	Total avoided impact	Net impact with RL	Increase (%)	% transport of total
Climate change	kg CO2 eq	3.37E+05	6.92E+04	9.61E+03	1.53E+04	1.94E+06	2.37E+06	-4.81E+05	-1.96E+05	1.69E+06	2.48E+05	2.62E+06	-6.77E+05	1.94E+06	10.44%	9.46%
Ozone depletion	kg CFC-11 eq	8.00E-02	1.00E-02	0.00E+00	0.00E+00	0.00E+00	1.00E-01	-3.00E-02	-1.00E-02	6.00E-02	4.36E-02	1.34E-01	-4.00E-02	9.36E-02	33.60%	32.64%
Human Toxicity - non cancer	CTUh	1.10E-01	1.00E-02	0.00E+00	0.00E+00	4.20E+00	4.32E+00	-4.69E+00	-1.80E-01	-5.50E-01	5.67E-02	4.38E+00	-4.87E+00	-4.93E-01	1.31%	1.29%
Human Toxicity - cancer effects	CTUh	2.00E-02	0.00E+00	0.00E+00	0.00E+00	6.00E-02	8.00E-02	-1.60E-01	-1.50E-01	-2.30E-01	7.83E-03	8.78E-02	-3.10E-01	-2.22E-01	9.79%	8.92%
Particulate matter	kg PM2.5 eq	5.64E+02	4.73E+03	2.95E+00	1.74E+01	4.37E+01	5.36E+03	-2.87E+03	-5.54E+02	1.93E+03	1.16E+02	5.47E+03	-3.43E+03	2.05E+03	2.16%	2.11%
Ionizing radiation HH	kBq U235 eq	4.20E+04	5.01E+03	5.91E+02	8.74E+02	3.82E+03	5.23E+04	-3.03E+04	-1.74E+04	4.61E+03	1.73E+04	6.96E+04	-4.77E+04	2.19E+04	33.10%	24.87%
Ionizing radiation E (interim)	CTUe	1.40E-01	2.00E-02	0.00E+00	1.00E-02	2.00E-02	1.80E-01	-1.20E-01	-7.00E-02	-1.00E-02	1.11E-01	3.01E-01	-1.90E-01	1.11E-01	67.25%	36.89%
Photochemical ozone formation	kg NMVOC eq	8.76E+02	2.55E+02	4.41E+01	3.06E+02	8.72E+02	2.35E+03	-7.52E+03	-2.45E+03	-7.61E+03	1.32E+03	3.67E+03	-9.96E+03	-6.29E+03	56.05%	35.92%
Acidification	molc H+ eq	1.85E+03	1.49E+03	4.34E+01	4.76E+02	3.80E+02	4.24E+03	-5.10E+04	-9.31E+03	-5.60E+04	1.28E+03	5.52E+03	-6.03E+04	-5.47E+04	30.26%	23.23%
Terrestrial eutrophication	molc N eq	3.26E+03	1.58E+03	1.72E+02	1.20E+03	1.04E+03	7.25E+03	-2.36E+04	-1.00E+04	-2.64E+04	4.71E+03	1.20E+04	-3.36E+04	-2.17E+04	65.04%	39.41%
Freshwater eutrophication	kg P eq	1.42E+02	1.48E+01	1.90E-01	9.00E-02	4.23E+01	1.99E+02	-1.77E+03	-1.38E+02	-1.71E+03	2.13E+01	2.21E+02	-1.91E+03	-1.69E+03	10.70%	9.67%
Marine eutrophication	kg N eq	4.15E+02	1.61E+02	1.56E+01	1.07E+02	4.95E+03	5.65E+03	-1.67E+03	-7.13E+02	3.26E+03	4.32E+02	6.08E+03	-2.39E+03	3.69E+03	7.64%	7.10%
Freshwater ecotoxicity	CTUe	4.07E+06	1.52E+06	2.60E+04	3.57E+03	3.12E+08	3.18E+08	-4.52E+08	-2.36E+07	-1.58E+08	2.06E+06	3.20E+08	-4.75E+08	-1.56E+08	0.65%	0.65%
Land Use	kg C deficit	6.69E+04	9.61E+04	2.46E+02	9.96E+01	6.46E+04	2.28E+05	-1.54E+06	-8.17E+05	-2.13E+06	9.56E+05	1.18E+06	-2.35E+06	-1.17E+06	419.54%	80.75%
Water resource depletion	m3 water eq	8.47E+01	4.65E+02	3.06E+00	9.10E-01	-2.20E+01	5.32E+02	-4.52E+02	-2.02E+02	-1.22E+02	4.98E+02	1.03E+03	-6.54E+02	3.76E+02	93.68%	48.37%
Mineral, fossil & ren resource depletion	kg Sb eq	5.85E+00	2.68E+00	1.00E-02	0.00E+00	5.00E-02	8.60E+00	-7.64E+02	-5.53E+02	-1.31E+03	5.19E-02	8.64E+00	-1.32E+03	-1.31E+03	0.49%	0.60%

Scenario 4 (2026)

Impact category	Unity	External recycling (411 t)	Brazil recycling (1.232,4 t)	Intermediary transport(82.200 tkm)	Sea transport (3.847.3 tkm)	Landfill (1.643.00 t)	Total	Avoided impact of external recycling	Avoided impact of Brazil recycling	Net impact scenario 4	Transport LR Brazil - 4.403.912 tkm	Total with LR brazil	Total avoided impact	Net impact with RL	Increase (%)	% transport of total
Climate change	kg CO2 eq	5.11E+05	6.29E+05	1.46E+04	2.31E+04	1.15E+06	2.33E+06	-7.29E+05	-1.78E+06	-1.83E+05	7.50E+05	3.08E+06	-2.51E+06	5.66E+05	32.21%	24.36%
Ozone depletion	kg CFC-11 eq	1.30E-01	9.00E-02	0.00E+00	0.00E+00	0.00E+00	2.30E-01	-4.00E-02	-1.20E-01	6.00E-02	1.32E-01	3.52E-01	-1.60E-01	1.92E-01	53.03%	37.50%
Human Toxicity - non cancer	CTUh	1.70E-01	6.00E-02	0.00E+00	0.00E+00	2.47E+00	2.71E+00	-7.12E+00	-1.65E+00	-6.06E+00	1.71E-01	2.87E+00	-8.77E+00	-5.90E+00	5.96%	5.97%
Human Toxicity - cancer effects	CTUh	3.00E-02	2.00E-02	0.00E+00	0.00E+00	4.00E-02	8.00E-02	-2.40E-01	-1.39E+00	-1.56E+00	2.37E-02	1.14E-01	-1.63E+00	-1.52E+00	42.13%	20.85%
Particulate matter	kg PM2.5 eq	8.56E+02	4.30E+04	4.47E+00	2.64E+01	2.58E+01	4.39E+04	-4.36E+03	-5.03E+03	3.45E+04	3.50E+02	4.42E+04	-9.39E+03	3.48E+04	0.74%	0.79%
Ionizing radiation HH	kBq U235 eq	6.37E+04	4.55E+04	8.97E+02	1.33E+03	2.25E+03	1.14E+05	-4.60E+04	-1.58E+05	-9.01E+04	5.24E+04	1.66E+05	-2.04E+05	-3.77E+04	45.70%	31.54%
Ionizing radiation E (interim)	CTUe	2.10E-01	1.50E-01	1.00E-02	1.00E-02	1.00E-02	3.90E-01	-1.80E-01	-6.10E-01	-4.00E-01	3.36E-01	7.26E-01	-7.90E-01	-6.39E-02	86.19%	46.29%
Photochemical ozone formation	kg NMVOC eq	1.33E+03	2.32E+03	6.69E+01	4.64E+02	5.15E+02	4.69E+03	-1.14E+04	-2.22E+04	-2.89E+04	3.99E+03	8.68E+03	-3.36E+04	-2.49E+04	85.16%	45.97%
Acidification	molc H+ eq	2.81E+03	1.35E+04	6.58E+01	7.22E+02	2.24E+02	1.73E+04	-7.73E+04	-8.45E+04	-1.44E+05	3.88E+03	2.12E+04	-1.62E+05	-1.41E+05	22.58%	18.30%
Terrestrial eutrophication	molc N eq	4.95E+03	1.43E+04	2.61E+02	1.81E+03	6.10E+02	2.19E+04	-3.59E+04	-9.08E+04	-1.05E+05	1.43E+04	3.62E+04	-1.27E+05	-9.05E+04	65.37%	39.40%
Freshwater eutrophication	kg P eq	2.16E+02	1.34E+02	2.90E-01	1.40E-01	2.49E+01	3.76E+02	-2.68E+03	-1.26E+03	-3.56E+03	6.46E+01	4.40E+02	-3.94E+03	-3.50E+03	17.10%	14.67%
Marine eutrophication	kg N eq	6.29E+02	1.46E+03	2.37E+01	1.63E+02	2.92E+03	5.20E+03	-2.54E+03	-6.47E+03	-3.81E+03	1.31E+03	6.50E+03	-9.01E+03	-2.51E+03	25.04%	20.09%
Freshwater ecotoxicity	CTUe	6.17E+06	1.38E+07	3.94E+04	5.41E+03	1.84E+08	2.04E+08	-6.85E+08	-2.15E+08	-6.96E+08	6.25E+06	2.10E+08	-9.00E+08	-6.90E+08	3.08%	2.97%
Land Use	kg C deficit	1.02E+05	8.73E+05	3.73E+02	1.51E+02	3.81E+04	1.01E+06	-2.33E+06	-7.42E+06	-8.74E+06	2.89E+06	3.91E+06	-9.75E+06	-5.84E+06	286.98%	74.07%
Water resource depletion	m3 water eq	1.28E+02	4.22E+03	4.64E+00	1.38E+00	-1.30E+01	4.34E+03	-6.85E+02	-1.84E+03	1.82E+03	1.51E+03	5.85E+03	-2.52E+03	3.33E+03	34.85%	25.76%
Mineral, fossil & ren resource depletion	kg Sb eq	8.87E+00	2.43E+01	1.00E-02	0.00E+00	3.00E-02	3.33E+01	-1.16E+03	-5.02E+03	-6.14E+03	1.57E-01	3.34E+01	-6.18E+03	-6.14E+03	0.32%	0.47%

SUPPLEMENTARY MATERIAL 16 - LIBs landfill modelling

DETRITUS - Detritus – Multidisciplinary Journal for Circular Economy and Sustainable Management of Residues

Title: LIFE CYCLE ASSESSMENT OF SCENARIOS FOR END-OF-LIFE MANAGEMENT OF LITHIUM-ION BATTERIES FROM SMARTPHONES AND LAPTOPS

Content:

	Emission to air	Sc1	Sc2	Sc3	Sc4	Total
kg/100 years	CH4	18.82	18.07	17.92	10.57	65.38
	C2H4	7.53	7.24	7.18	4.23	26.18
	CO2	73.402.68	70.491.67	69.914.49	41.230.98	255.040
	Emission to water					
	Li	8.464.14	8.128.47	8.061.91	4.754.39	29.408.92
	Al	21.911.32	21.042.36	20.870.06	12.307.79	76.131.53
	Cu	37.884.05	36.381.64	36.083.75	21.279.83	131.629.28
	Co	21.107.95	20.270.85	20.104.87	11.856.54	73.340.21
	Ni	21.107.95	20.270.85	20.104.87	11.856.54	73.340.21
	Mn	20.397.64	19.588.71	19.428.32	11.457.55	70.872.21

The comparison between the landfill results of the scenarios shows that modelling the LIBs landfill with limited data is not adequate, as several emissions could not be accounted for, as well as the destination of such emissions. Figure S1 shows that comparing the average landfill used with the limited LIBs landfill that was proposed, the results for the climate change category is much lower than the average landfill. In contrast, for the Freshwater ecotoxicity and Human toxicity - cancer effects categories, the amount of metals leached from the LIBs causes much more impact compared to the average landfill. Therefore, the landfill results in the evaluation of LIB waste management scenarios should be interpreted with caution, since not all the potential toxicity or GHG emissions can be modelled and the average landfill does not capture all the potential toxicity from metals. Further studies into the disposal of LIBs in landfill is urgent.

Figure S1. Comparison between landfil modelling LIBs specific waste and medium landfill.

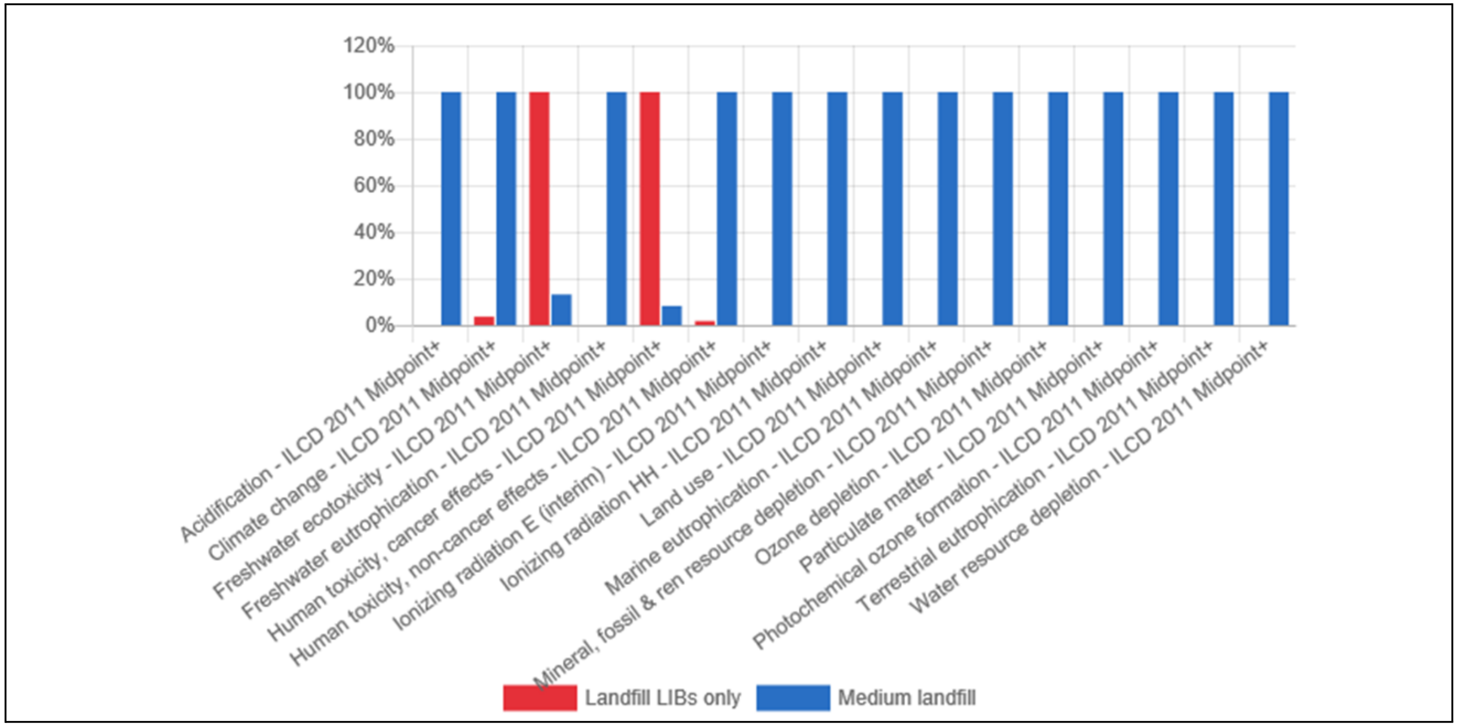

Table S16. Assumptions for LIBs landfill modelling - specific waste

Methodological steps	Assumptions	Reference
1.	Following Gabor Doka (2023) guidelines for landfill modelling: when it is not possible to obtain detailed landfill emissions data for a specific waste, possible emissions should be inventoried based on the chemical composition of all materials.	Doka (2023)
2.	The list of LIB cell materials was mapped and the chemical composition of the main materials was calculated down to the elemental level.	Wang et al. (2016) / Dai et al. (2019)
3.	To make the theoretical model easier to understand, the compositions were modelled using the material production of the NMC111 cathode as a proxy. This is why the amount of metals is different from the output of the recycling process, because there is a mixture of different types of cathodes (NMC and LiCoO2 for example) which can change the concentration of certain specific materials such as cobalt in a crushed sample.	
4.	The amount of each chemical element in each material was calculated by converting mass values to moles and then to the mass value of each element again. Finally, each chemical element was added together to provide an elemental composition inventory for each LIB cell.	
5.	As LIBs have different elements (C, H, O, P, F, Li, Al, Cu, Co, Ni) it can be seen that different types of substances can be generated if LIBs are dumped in landfill sites, such as methane, carbon dioxide, hydrogen fluoride or hydrofluorocarbon (HFC) gases and heavy metal leachates. However, as the composition is complex and there is no detailed data on the interactions that can occur with LIBs in a landfill environment, it was not possible to model the possible chemical reactions. However, we did find some data on methane, ethylene and carbon dioxide emissions from discarded plastics fractions of LIBs (PET, PP, PE) (Royer et al., 2018; Shaw et al., 2023). Photo-degradation of the plastic produce CH4 and CO2 (Shaw et al., 2023). Also a study presenting the potential for metal leaching from LIBs in landfill sites (Kilgo et al., 2022). Therefore, these data were adapted to calculate the potential greenhouse gas generation and leaching of LIBs in landfill. Although this emission potential is very limited compared to the emission potential of LIBs in landfills, since different additives can be added to the materials as well, we would like to check whether the results of global warming potential and toxicity categories could be somewhat comparable to the	Royer et al. (2018) / Shaw et al. (2023) / Kilgo et al. (2022)

	results of the average landfill used.	
6.	The emissions from plastics were modeled considering 100 years. This time horizon was chosen assuming the premises of other studies that modeled landfills, where the potential for landfill emissions is considered up to 100 years and then stabilizes (Kirkeby et al., 2007).	Kirkeby et al. (2007)
7.	For the calculation of leached metals, it was assumed that only 10% of the total metal fraction is leached, as Kilgo et al. (2022) provides data suggesting that metals from LIBs can adhere to other materials in landfills and biofilms and may not be entirely leached. The 10% value was chosen based on the average results from Kilgo et al. (2022) and considering the highest possible rate. Furthermore, we assume that these 10% are leached into groundwater, but this is a rough approximation since heavy metals from leachate can deposit in soil, water, or plants(Beinabaj et al., 2023). Due to a lack of data, we were unable to model the concentration in each environmental compartment	
8.	The emissions of CH_4, CO_2, and C_2H_4 were modeled in g by g of plastic per day. The results of CO_2 is extrapoled to mol/g plastic/day. In original study the value of the 20umol is to 45 days of experimental and authors point that these concentrations were not converted in the unit µmol/g/d because using this unit needs an assumption that emissions rates of CO_2 and CH_4 were uniform from 0 to 45 days, this may not fully reflect reality. However, we considered the rate of CO_2 µmol/g plastic/day as it was the best available data. For methane and ethylene, the reference study provides the average daily emission in unit nmol/ g plastic / day (Royer et al., 2018).	
9.	Potential emissions to the air and water are provided in kg of substance for each evaluated scenario, considering the quantity destined for the landfill and emissions per 100 years.	

		Components															1 kg of LIBs (23.7 cells)	1 t
	Chemical element	LiCO3	PVFD	EC	DMC	PP	PE	PET	Carbon black	Graphite	LiPF6	Mixed metal - cathode	Casing	Current collector	Total (g/cell)	kg	23.7 (kg/kg)	(kg/t)
Potential formation of CO2, hydrocarbons and hydrofluorocarbon (HFC) due to compounds composed of hydrogen, fluorine, and carbon.	C	1.02	0.49	1.12	1.10	0.57	0.13	0.08	1.03	8.54					14.08	0.01408	0.334	333.59
	H		0.04	0.13	0.18	0.10	0.02	0.01							0.48	0.00048	0.011	11.27
	O	4.07		1.49	1.46			0.04							7.06	0.00706	0.167	167.31
	P										0.20				0.20	0.00020	0.005	4.73
	F		0.78								0.73				1.51	0.00151	0.036	35.81
	Li	1.18									0.04				1.22	0.00122	0.029	28.94
	Al												0.80	2.36	3.16	0.00316	0.075	74.91
	Cu													5.46	5.46	0.00546	0.130	129.52
	Co											3.04			3.04	0.00304	0.072	72.16
	Ni											3.04			3.04	0.00304	0.072	72.16
	Mn											2.94			2.94	0.00294	0.070	69.74

Molar mass of molecules		Average emissions (Royer et al., 2018)			Shaw et al. (2023)	Values of emissions by g of plastic			Plastic in LIBs cell	Values of emissions by LIB cell		
mol mas	g/mol	Plastic	CH4 nmol/d /g plastic	C2H4 nmol/d /g plastic	CO2 µmol/d/g plastic	g CH4/g plastic/d	g C2H4/g plastic/d	g CO2 / g plastic/d	g plastic/cell	CH4 g/cell/d	C2H4 g/cell / d	CO2 / cell / d
C2H4	28.05	PET	0.5	64	0.44	0.00000000802	0.0000000017952	0.0000193644	67.098	0.00000000538125960	0.000000001204543296	0.00001299312511
CH4	16.04	PE	0.09	0.19	0.44	0.0000000014436	0.0000000053295	0.0000193644	15.614	0.00000000022540370	0.00000000083214813	0.0000030236
CO2	44.01	PP	0.17	0.05	0.44	0.0000000027268	0.0000000014025	0.0000193644	67.098	0.00000000182962826	0.00000000094104945	0.00001299312511

value in mol	CH4 mol/g plastic	C2H4 mol/g plastic	CO2 mol/g plastic
PET	0.0000000005	0.0000000001	0.00000044
PE	0.00000000009	0.0000000002	0.00000044
PP	0.0000000002	0.0000000001	0.00000044

Mass/mol	g/mol	g/mol	g/mol
PET	0.00000000802	0.0000000017952	0.0000193644
PE	0.0000000014436	0.0000000053295	0.0000193644
PP	0.0000000027268	0.0000000014025	0.0000193644

1 kg (23,7 cells)		
CH4 g /d	C2H4 g /d	CO2 / cell /d
0.0000001275358525	0.00000002854767612	0.0003079370652
0.000000005342067785	0.00000001972191068	0.00007165831076
0.00000004336218986	0.00000002230287197	0.0003079370652

1 ton		
CH4 g /d	C2H4 g / d	g CO2 / d
0.0001275358525	0.00002854767612	0.31
0.000005342067785	0.00001972191068	0.07
0.00004336218986	0.00002230287197	0.31
0.0001762401102	0.00007057245876	0.69

		Landfill (g/scenarios/day)			
	emissions / day	Sc1	Sc2	Sc3	Sc4
	LIBs landifilled (t/year)	2.925	2.809	2.786	1.643
	CH4	0.52	0.50	0.49	0.29
	C2H4	0.21	0.20	0.20	0.12
	CO2	2.011.03	1.931.28	1.915.47	1.129.62
	emissions / day	(kg /scenarios)			
	CH4	0.00052	0.00050	0.00049	0.00029
	C2H4	0.00021	0.00020	0.00020	0.00012
	CO2	2.01	1.93	1.92	1.13
100 years	365 days/year*100 years	Sc1	Sc2	Sc3	Sc4
	CH4	18.82	18.07	17.92	10.57
	C2H4	7.53	7.24	7.18	4.23
	CO2	73.402.68	70.491.67	69.914.49	41.230.98

							Sc1	Sc2	Sc3	Sc4	
Chemical element	g/cell	10% of total available (Kilgo et al., 2022)	1 kg de LIBs (23,7 cells) (g/kg)	1 t of cells (g/t)	kg/t	LIBs landfilled (t/year)	2.925	2.809	2.786	1.643	Total emissions (kg)
Li	1.22	0.1220980527	2.893723849	2893.723849	2.893723849	Li	8.464.14	8.128.47	8.061.91	4.754.39	29.408.92
Al	3.16	0.316078	7.4910486	7491.0486	7.4910486	Al	21.911.32	21.042.36	20.870.06	12.307.79	76.131.53
Cu	5.46	0.54649	12.951813	12951.813	12.951813	Cu	37.884.05	36.381.64	36.083.75	21.279.83	131.629.28
Co	3.04	0.3044892048	7.216394154	7216.394154	7.216394154	Co	21.107.95	20.270.85	20.104.87	11.856.54	73.340.21
Ni	3.04	0.3044892048	7.216394154	7216.394154	7.216394154	Ni	21.107.95	20.270.85	20.104.87	11.856.54	73.340.21
Mn	2.94	0.2942427072	6.973552161	6973.552161	6.973552161	Mn	20.397.64	19.588.71	19.428.32	11.457.55	70.872.21

Element	g/mol
Li	6.941
C	12.011
O	16
Co	58.93
Ni	58.69
Mn	54.93
H	1.01
F	18.998
Cu	63.54
Al	26.8
P	30.97

Name	Formula	g/mol	Mass in the LIB cell (g)
Lithium carbonate	Li2CO3	73.89	6.261068832
Cobalt	Co	58.93	3.044892048
Nickel	Ni	58.69	3.044892048
Manganese	Mn	54.93	2.942427072
Carbon black	C	12.011	1.02968
Graphite	C	12.011	8.53706
Binder (PVDF)	(CH2CF2)n	64.038	1.3082
Copper	Cu	63.54	5.4649
Aluminum	Al	26.8	2.35898
Electrolyte salt	LiPF6	151.899	0.97904
Electrolyte solvent (EC)	C3H4O3	88.073	2.73878
Electrolyte solvent (DMC)	C3H6O3	90.093	2.73878
Plastic: PP	(C3H6)n	42.093	0.67098
Plastic: PE	(C2H4)n	28.062	0.15614
Plastic: PET	(C10H8O4)n	192.19	0.12238
Aluminum	Al	26.8	0.8018
			42.2

Mols
0.085
0.052
0.052
0.054
0.086
0.711
0.020
0.086
0.088
0.006
0.031
0.030
0.016
0.006
0.001
0.030

LiCO3				
Li	C	O		
0.169463111	0.08473155552	0.2541946666	mol	
1.176243454	1.017710713	4.067114665	6.261068832	g

PVFD				
C	H	F		
0.04085699116	0.04085699116	0.04085699116	mol	
0.4907333208	0.04126556107	0.7762011181	1.3082	g

LiPF6				
Li	P	F		
0.006445335387	0.006445335387	0.03867201232	mol	
0.04473707292	0.1996120369	0.7346908901	0.97904	g

EC				
C	H	O		
0.09329011161	0.1243868155	0.09329011161	mol	
1.120507531	0.1256306836	1.492641786	2.73878	g

DMC				
C	H	O		
0.09119842829	0.1823968566	0.09119842829	mol	
1.095384322	0.1842208251	1.459174853	2.73878	g

PP				
C	H			
0.04782125294	0.09564250588	mol		
0.5743810691	0.09659893094	0.67098		g

PE				
C	H			
0.01112821609	0.02225643219	mol		
0.1336610035	0.02247899651	0.15614		g

PET				
C	H	O		
0.006367657006	0.005094125605	0.002547062802	mol	
0.0764819283	0.005145066861	0.04075300484	0.12238	g

					Cell weight (g)				
					42,2				
Part	Components	Material	Description	Chemical formula	% weight in LIB cell	Mass of each component (g)			
				LiNiCoMn	36.24%	15.29328			
				Li2CO3	7.30%	1.11640944	5.144659392	6.261068832	Weight carbonate: (+/- 33, 64%)
Cathode	Active material powder	NMC 111 cathode	NMC111 cathode is made (%): Li = 7.30; Co = 19.91; Ni = 19.91; Mn = 19.24 (Young, 2020)	Co	19.91%	3.044892048			
				Ni	19.91%	3.044892048			
				Mn	19.24%	2.942427072			
Cathode	Carbon black	Used in cathode	Carbon black is an engineered material, primarily composed of elemental carbon, obtained from the partial combustion or thermal decomposition of hydrocarbons.	C	2.44%	1.02968			
Anode	Graphite		Graphite is mineral consisting of carbon. Graphite has a layered structure that consists of rings of six carbon atoms arranged in widely spaced horizontal sheets	C	20.23%	8.53706			
Binder	Binder (PVDF)	Polyvinylidene fluoride - PVDF	PVDF is a semi-crystalline thermoplastic fluoropolymer	(CH2CF2)n	3.10%	1.3082			
Negative current collector	Copper	Cu		Cu	12.95%	5.4649			
Positive current collector	Aluminum	Al		Al	5.59%	2.35898			
Electrolyte	Electrolyte salt	Lithium hexafluorophosphate (1 mol/L electrolyte)	Lithium hexafluorophosphate (LiPF6) is the most widely used salt in the electrolytes for commercial Li-ion cells.	LiPF6	2.32%	0.97904			
	Electrolyte solvent	Ethylene Carbonate - EC (1:1)	Ethylene carbonate is commercially produced by the reaction of ethylene oxide and carbon dioxide	C3H4O3	6.49%	2.73878			
	Electrolyte solvent	Dimethyl Carbonate - DMC (1:1)	Dimethyl Carbonate (DMC) is a colorless, fast evaporating VOC-exempt solvent.	C3H6O3	6.49%	2.73878			
Separator	Plastic: PP	Polypropylene (50%)	Polypropylene is created through polymerization of propylene gas. It is obtained from high temperature cracking of petroleum hydrocarbons and propane.	(C3H6)n	1.59%	0.67098			
	Plastic: PE	Polyethylene (50%)	Polyethylene is a polymer formed from ethylene	(C2H4)n	0.37%	0.15614			
Cell container	Plastic: PET	Polyethylene Terephthalate	PET is a polyester and is made by the transesterification reaction between ethylene glycol and dimethyl terephthalate	(C10H8O4)n	0.29%	0.12238			
	Aluminum	Al		Al	1.90%	0.8018			
					100.00%				

Chemical formula	1kg of LIBs	1t LIBs	kg/ton	LIBs landfilled (t/year)	kg / scenarios 2.925	2.809	2.786	1.643
LiNiCoMn								
Li2CO3	26.45890373	26.458.90	26.45890373		77.392.29	74.323.06	73.714.51	43.471.98
Co	72.16394154	72.163.94	72.16394154		211.079.53	202.708.51	201.048.74	118.565.36
Ni	72.16394154	72.163.94	72.16394154		211.079.53	202.708.51	201.048.74	118.565.36
Mn	69.73552161	69.735.52	69.73552161		203.976.40	195.887.08	194.283.16	114.575.46
C	24.403416	24.403.42	24.403416		71.379.99	68.549.20	67.987.92	40.094.81
C	202.328322	202.328.32	202.328322		591.810.34	568.340.26	563.686.71	332.425.43
(CH2CF2)n	31.00434	31.004.34	31.00434		90.687.69	87.091.19	86.378.09	50.940.13
Cu	129.51813	129.518.13	129.51813		378.840.53	363.816.43	360.837.51	212.798.29
Al	55.907826	55.907.83	55.907826		163.530.39	157.045.08	155.759.20	91.856.56
LiPF6	23.203248	23.203.25	23.203248		67.869.50	65.177.92	64.644.25	38.122.94
C3H4O3	64.909086	64.909.09	64.909086		189.859.08	182.329.62	180.836.71	106.645.63
C3H6O3	64.909086	64.909.09	64.909086		189.859.08	182.329.62	180.836.71	106.645.63
(C3H6)n	15.902226	15.902.23	15.902226		46.514.01	44.669.35	44.303.60	26.127.36
(C2H4)n	3.700518	3.700.52	3.700518		10.824.02	10.394.76	10.309.64	6.079.95
(C10H8O4)n	2.900406	2.900.41	2.900406		8.483.69	8.147.24	8.080.53	4.765.37
Al	19.00266	19.002.66	19.00266		55.582.78	53.378.47	52.941.41	31.221.37