Life Cycle Assessment of Metal Packaging in Europe

EXECUTIVE SUMMARY – June 2022

Metal Packaging Europe (MPE) is the association of European producers of rigid metal packaging bringing together over 300 manufacturers, and their national associations, which employs over 60,000 people in 23 European countries.

With growing demand for sustainable production and consumption, MPE is fully committed to provide objective and reliable information about the environmental performance of rigid metal packaging. For this reason, MPE commissioned an in-depth Life Cycle Assessment (LCA) conducted by RDC Environment and reviewed by Solinnen according to the requirements of the international standard ISO 14040/44.

Based on 2018 production data, the study covers the life cycle of metal packaging produced in Europe, from raw material extraction through manufacturing and end-of-life (see Figure 6) and the following packaging categories: aluminium beverage cans, aluminium and steel food cans, steel aerosol, steel general line, steel closures and steel speciality packaging.

Production data was collected from multiple manufacturing plants across Europe resulting in a coverage of the European metal packaging production of approximately 42% for steel packaging and 82% for aluminium packaging, according to market estimates. The following members of Metal Packaging Europe submitted data for the study: Ardagh Group, Ball Packaging, Colep, Crown Packaging Europe, Envases, Eviosys, Massilly, Pelliconi, Sarten, Silgan, and Trivium Packaging.

The environmental performance of metal packaging is calculated according to the functional unit, which is one thousand (1,000) units of packaging, and described by 16 impact categories recommended by the Environmental Footprint methodology of the European Commission (see Table 5).

The results of the Climate Change impact are listed in the tables below per one unit of packaging and its average weight; the full range of impact assessment is reported in Figure 7 and Figure 8. More details are provided in the Methodological Report available at MPE website (link).

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	Alu bev can 250 ml	Alu bev can 330 ml	Alu bev can 500 ml	Alu food can 125 ml
Average weight (g)	**10**	**12**	**15**	**15**
Climate Change (g CO_2 eq.)	**51**	**61**	**78**	**75**
Climate Change impact per life cycle phase (g CO_2 eq.)				
Raw materials & transport	*96*	*113*	*138*	*139*
Can manufacturing	*13*	*15*	*19*	*10*
Secondary & tertiary packaging	*2*	*2*	*3*	*0*
Transport to fillers	*5*	*6*	*10*	*16*
End-of-Life (recycling & disposal)	*-64*	*-75*	*-93*	*-91*

Table 1 Average weight and Climate Change impact of 1 unit of aluminium packaging

	Steel food can 425 ml	Steel aerosol 420 ml	Steel aerosol 520 ml	Steel general line 2500 ml	Steel closure	Steel speciality packaging
Average weight (g)	**50**	**71**	**81**	**315**	**8**	**164**
Climate Change (g CO_2 eq.)	**100**	**160**	**180**	**610**	**19**	**360**
Climate Change impact per life cycle phase (g CO_2 eq.)						
Raw materials & transport	*123*	*174*	*197*	*779*	*20*	*420*
Can manufacturing	*21*	*38*	*43*	*105*	*5*	*62*
Secondary & tertiary packaging	*1*	*1*	*1*	*7*	*0*	*3*
Transport to fillers	*9*	*16*	*19*	*47*	*1*	*41*
End-of-Life (recycling & disposal)	*-51*	*-73*	*-83*	*-333*	*-8*	*-162*

Table 2 Average weight and Climate Change impact of 1 unit of steel packaging

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On average across the aluminium packaging categories, the contribution to the Climate Change impact of the can manufacturing process is ~22% whereas the contribution of the raw material production and transport plus the end-of-life (recycling & disposal) is ~62%. The transport to fillers accounts for ~14% and the secondary and tertiary packaging for ~3%.

On average across the steel packaging categories, the contribution to the Climate Change impact of the can manufacturing process is ~22% whereas the contribution of the raw material production and transport plus the end-of-life (recycling & disposal) is ~68%. The transport to fillers accounts for ~9% and the secondary and tertiary packaging for ~1%.

In the above tables the values of the "End-of-Life (recycling & disposal)" phase are negative, representing an environmental benefit. By recycling the cans into the same material system from which they were generated (so-called closed loop approach) emissions due to primary metal production are avoided. Emissions from secondary metal production are lower than those from primary metal production.

On average across the metal packaging categories, recycling metal packaging at the rates used in the study (i.e. 76% for beverage cans and 84% for steel packaging) reduces the greenhouse gases emissions of the primary production respectively by around 68% for aluminium and 44% for steel. Made from permanent materials, metal packaging is a perfect fit for a Circular Economy: both aluminium and steel can be recycled over and over again without losing their intrinsic properties, allowing the materials to remain in the economy and therefore reducing the need for primary raw materials.

When compared to the previous LCAs[1], the study records significant reductions in greenhouse gases emissions, confirming the industry's commitment to reduce carbon emissions and to decouple production from its carbon footprint. The main factors which have made this progress possible are:

- improvements taking place in raw material production over time;
- improvements in the can manufacturing processes, including an increase in energy and resource efficiency[2];

[1] 2016 LCA of non-beverage metal packaging, EMPAC; 2019 LCA of aluminium beverage cans, Metal Packaging Europe

[2] For more details about the activities and commitments undertaken by MPE Members to increase the sustainability in the metal packaging industry, see this link

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- a reduction in can weight, of 2% for aluminium beverage cans, for example, and 1% for steel food cans; and
- an increase in aluminium and steel packaging recycling rates, with the beverage can recycling rate currently at 76% and steel packaging reaching 84%.

	Alu bev can 250 ml	Alu bev can 330 ml	Alu bev can 500 ml
Average weight (g) in 2016	10.4	12.2	15.2
Average weight (g) in 2018	10.2	12.1	14.8
Weight reduction (%) over 2016 – 2018 period	-2%	-1%	-3%

Table 3 Average can weight and percentage redution over the 2016 – 2018 period. Aluminium food cans 125 ml were included in this study for the first time

	Steel food can 425 ml	Steel aerosol can 520 ml	Steel general line 2500 ml	Steel closure
Average weight (g) in 2013	49.8	82.6	258.6	8.4
Average weight (g) in 2018	49.6	80.5	258.8	7.7
Weight reduction (%) over 2013 – 2018 period	-1%	-3%	0%	-9%

Table 4 Average can weight and percentage redution over the 2013 – 2018 period. Steel speciality packaging includes non-standardised products (e.g. for promotion purpose) for which the weight reduction cannot be measured meaningfully

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From a Climate Change perspective, results for the aluminium beverage cans (330 ml) show that the impact on Climate Change has been reduced by around 50% over the 2006 – 2018 period.

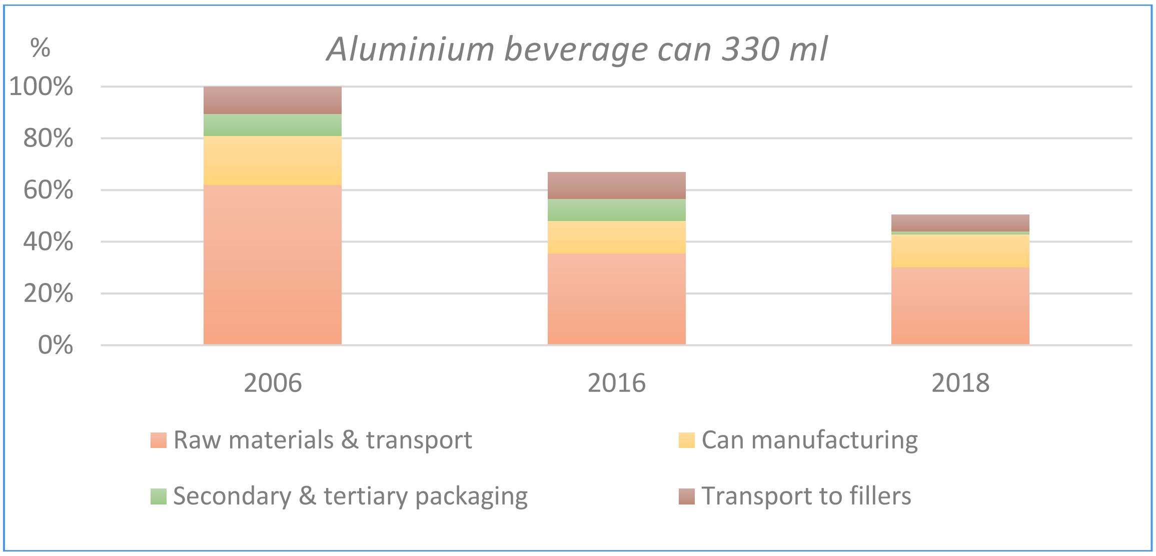

Figure 1 Climate Change impact reduction over the 2006 – 2018 period for average aluminium beverage cans (330 ml)

For steel packaging, results show that over the 2000 – 2018 period the impact on Climate Change has been reduced by:

- over 30% for food cans and general line packaging;
- just under 20% for aerosol can (2006 – 2018);
- over 40% for closures; and
- over 10% for speciality packaging.

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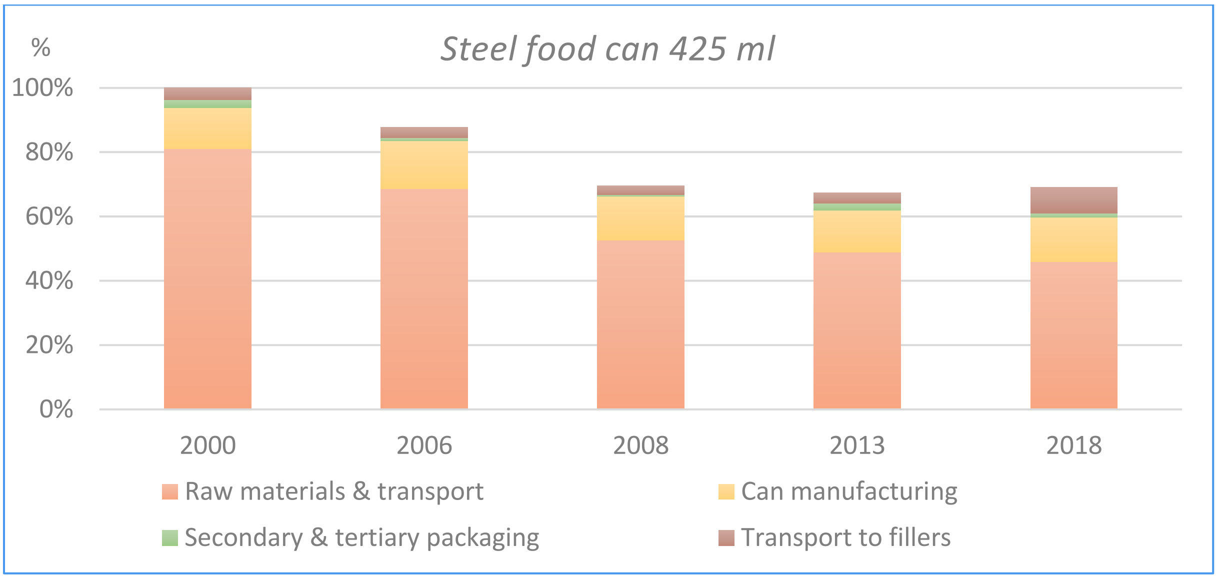

Figure 2 Climate Change impact reduction over the 2000 – 2018 period for average steel food cans (425 ml)

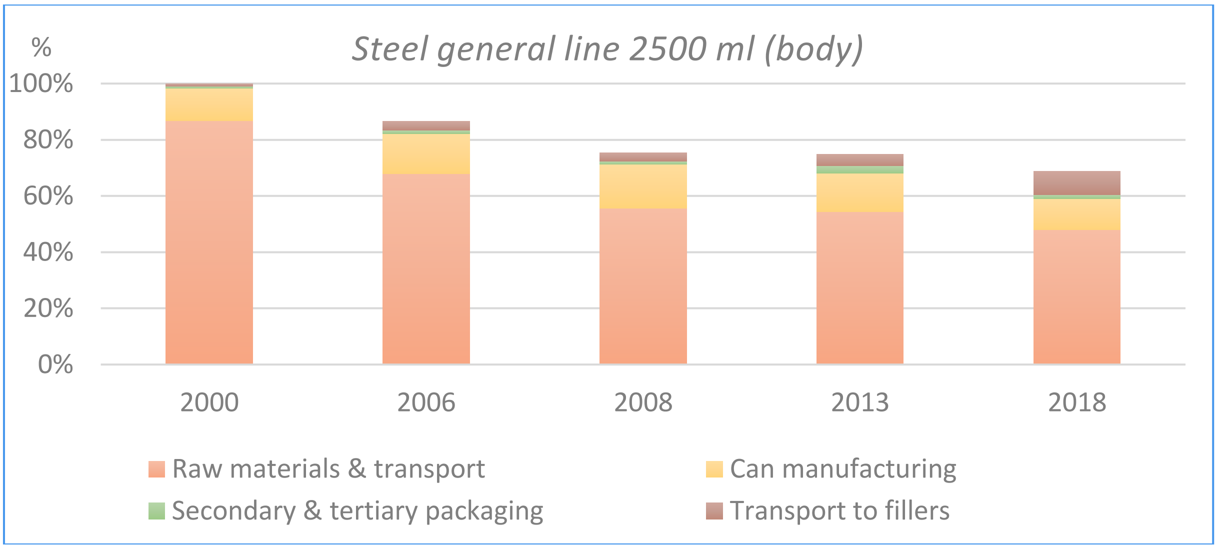

Figure 3 Climate Change impact reduction over the 2000 – 2018 period for average steel general line packaging (2500 ml)

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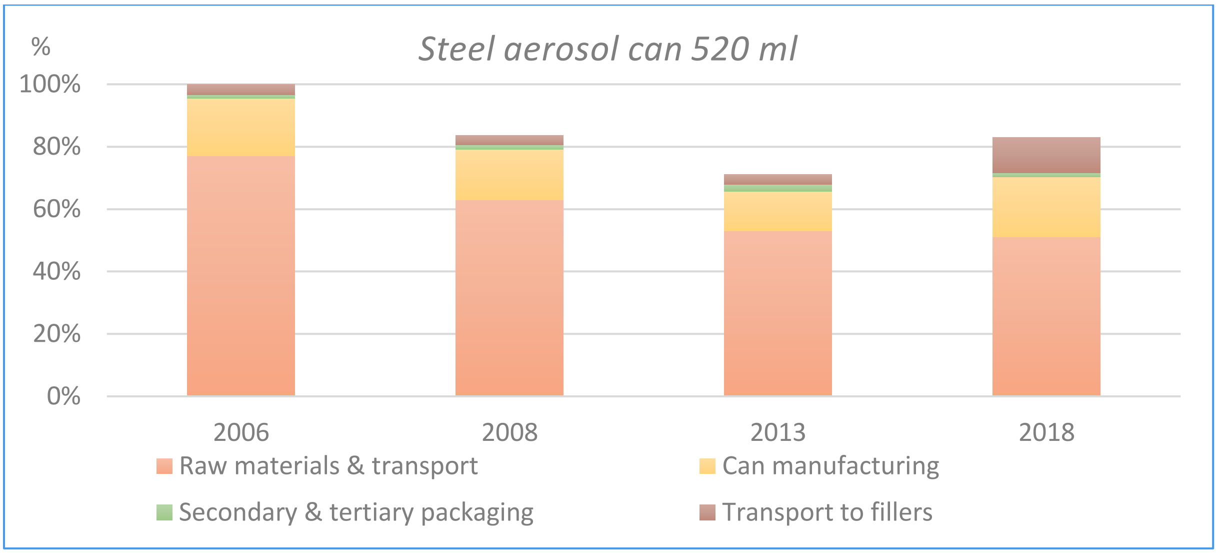

Figure 4 Climate Change impact reduction over the 2006 – 2018 period for average steel aerosol cans (520 ml)

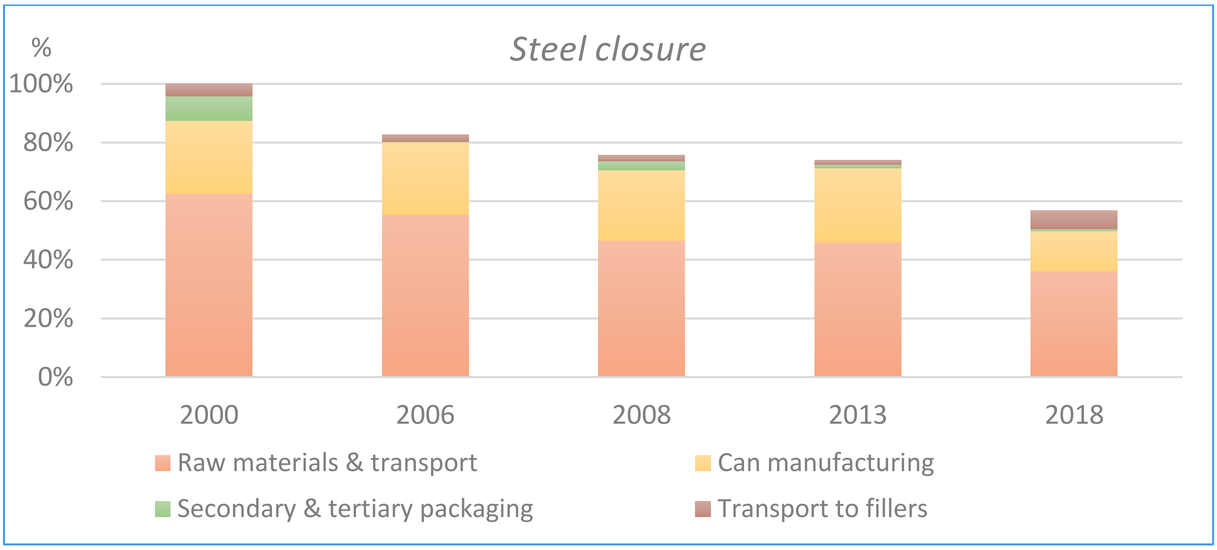

Figure 5 Climate Change impact reduction over the 2000 – 2018 period for average steel closures

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A specific analysis was carried out on the tinplate production to assess its Climate Change reduction over time: for this purpose, WorldSteel data was used which show an 8% reduction in greenhouse gases emissions over the 2013 – 2019[3] period. This improvement is not accounted in the above diagrams because the same data of the previous studies for aluminium and steel production (respectively provided by European Aluminium and APEAL) have been used in order to compare the results over time.

The analysis of the Climate Change reduction over time for the aluminium production was assessed in the previous LCA study, showing a 3% reduction in greenhouse gases emissions over the 2006 – 2016[4] period.

ADDITIONAL INFORMATION

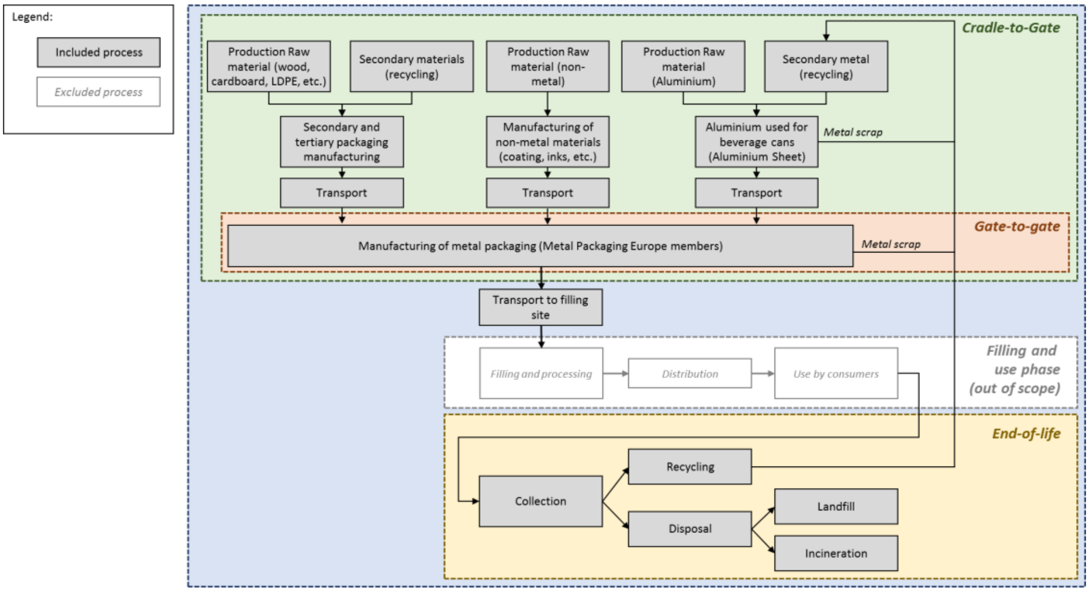

Figure 6 System boundaries of the LCA study

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[3] World Steel Association 2018 and 2020 Life Cycle Inventory studies. The 2020 publication covers the period 2015-2019, whereas the 2018 publication covers the period 2013-2017. The 8% reduction is therefore referred to the overall period 2013-2019.
[4] 2019 Life Cycle Assessment of Aluminium Beverage Cans in Europe, Metal Packaging Europe.

Impact categories	Unit	Aluminium beverage can 250 ml	Aluminium beverage can 330 ml	Aluminium beverage can 500 ml	Aluminium food can 125 ml
Climate Change	kg CO2-Eq.	5.1E+01	6.1E+01	7.8E+01	7.5E+01
Resource use, fossils	Energy, MJ	7.6E+02	9.1E+02	1.2E+03	1.1E+03
Particulate Matter	disease incidence	2.6E-06	3.1E-06	3.9E-06	3.7E-06
Acidification	Moles H+-eq.	2.7E-01	3.2E-01	4.1E-01	3.8E-01
Photochemical ozone formation - human health	kg NMVOC-eq.	1.6E-01	1.9E-01	2.4E-01	2.4E-01
Eutrophication terrestrial	Moles N-eq.	7.0E-01	8.4E-01	1.1E+00	9.4E-01
Resource use, minerals and metals	kg Antimony eq.	7.6E-05	9.2E-05	1.2E-04	1.3E-04
Eutrophication freshwater	kg P-eq.	8.2E-03	9.9E-03	1.3E-02	7.3E-03
Water use	Volume m3-world eq.	1.2E+01	1.4E+01	1.9E+01	1.3E+01
Land Use	dimensionless (pt)	3.3E+02	4.0E+02	5.5E+02	5.9E+02
Eutrophication marine	kg N-eq.	5.0E-02	6.0E-02	7.6E-02	7.5E-02
Ozone depletion	kg CFC11-eq.	2.9E-06	3.5E-06	5.0E-06	5.3E-06
Ionising radiation - human health	kBq Uranium-235 eq.	7.4E+00	8.9E+00	1.1E+01	9.5E+00
Cancer human health effects	CTUh	2.0E-07	2.5E-07	3.3E-07	3.3E-07
Non-cancer human health effects	CTUh	2.4E-06	2.9E-06	3.7E-06	3.2E-06
Ecotoxicity freshwater	CTUe	7.8E+00	9.5E+00	1.3E+01	1.2E+01

Figure 7 Environmental performance of 1,000 units of aluminium packaging

Impact categories	Unit	Steel food can 425 ml	Steel aerosol can 420 ml	Steel aerosol can 520 ml	Steel general line 2500 ml	Steel closure	Steel speciality
Climate Change	kg CO2-Eq.	1.0E+02	1.6E+02	1.8E+02	6.1E+02	1.9E+01	3.6E+02
Resource use, minerals and metals	kg Antimony eq.	2.1E-03	3.0E-03	3.4E-03	1.3E-02	3.2E-04	7.1E-03
Resource use, fossils	Energy, MJ	1.6E+03	2.4E+03	2.7E+03	9.1E+03	3.2E+02	5.5E+03
Particulate Matter	disease incidence	6.4E-06	9.5E-06	1.1E-05	3.9E-05	1.1E-06	2.3E-05
Acidification	Moles H+-eq.	5.3E-01	8.1E-01	9.1E-01	3.2E+00	9.4E-02	1.9E+00
Photochemical ozone formation - human health	kg NMVOC-eq.	4.1E-01	6.0E-01	6.8E-01	2.5E+00	7.8E-02	1.4E+00
Eutrophication terrestrial	Moles N-eq.	1.6E+00	2.4E+00	2.7E+00	9.4E+00	2.7E-01	5.4E+00
Water use	Volume m3-world eq.	5.3E+01	7.6E+01	8.5E+01	3.2E+02	8.9E+00	1.9E+02
Eutrophication marine	kg N-eq.	1.3E-01	2.0E-01	2.2E-01	8.1E-01	2.2E-02	4.6E-01
Eutrophication freshwater	kg P-eq.	1.2E-02	2.0E-02	2.3E-02	6.0E-02	2.7E-03	4.3E-02
Ozone depletion	kg CFC11-eq.	1.0E-05	1.6E-05	1.8E-05	5.9E-05	1.9E-06	3.9E-05
Land Use	dimensionless (pt)	7.5E+02	1.1E+03	1.3E+03	4.6E+03	1.2E+02	2.7E+03
Ionising radiation - human health	kBq Uranium-235 eq.	1.2E+01	1.8E+01	2.1E+01	6.7E+01	2.0E+00	4.1E+01
Cancer human health effects	CTUh	8.0E-07	1.2E-06	1.4E-06	5.0E-06	1.4E-07	3.1E-06
Non-cancer human health effects	CTUh	3.1E-05	4.6E-05	5.2E-05	1.9E-04	4.8E-06	1.1E-04
Ecotoxicity freshwater	CTUe	4.5E+01	6.5E+01	7.4E+01	2.8E+02	7.2E+00	1.6E+02

Figure 8 Environmental performance of 1,000 units of steel packaging

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Impact categories	Units	Indicator	Impact assessment model	Source of CFs	Robustness
Climate change	*kg CO2 eq.*	Radiative forcing as Global Warming Potential (GWP100)	Baseline model of 100 years of the IPCC (based on IPCC 2013)	EC-JRC, 2017	I
Ozone depletion	*kg CFC-11 eq.*	Ozone Depletion Potential (ODP)	Steady-state ODPs as in (WMO 1999)	EC-JRC, 2017	I
Human toxicity, cancer	*CTUh*	Comparative Toxic Unit for humans (CTUh)	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Human toxicity, non-cancer	*CTUh*	Comparative Toxic Unit for humans (CTUh)	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Ecotoxicity for aquatic freshwater	*CTUe*	Comparative Toxic Unit for ecosystems (CTUe)	USEtox model, (Rosenbaum et al, 2008)	EC-JRC, 2017	III/interim
Particulate matter	*disease incidence*	Impact on human health	PM method recomended by UNEP (UNEP 2016)	EC-JRC, 2017	I
Ionising radiation, human health	*kBq* U^{235} *eq*	Human exposure efficiency relative to U235	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)	EC-JRC, 2017	II
Photochemical ozone formation	*kg NMVOC eq*	Tropospheric ozone concentration increase	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008	EC-JRC, 2017	II
Acidification	*mol H+ eq.*	Accumulated Exceedance (AE)	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Terrestrial eutrophication	*mol N eq.*	Accumulated Exceedance (AE)	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	EC-JRC, 2017	II
Freshwater eutrophication	*kg P eq.*	Fraction of nutrients reaching freshwater end compartment (P)	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Marine eutrophication	*kg N eq.*	Fraction of nutrients reaching marine end compartment (N)	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	EC-JRC, 2017	II
Land use	Dimensionless (pt)	• Soil quality index • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)	EC-JRC, 2017	III
Resource depletion water	*m³ of water-eq*	User deprivation potential (deprivation-weighted water consumption)	Available WAter REmaining (AWARE) as recommended by UNEP, 2016	EC-JRC, 2017	III
Resource use, minerals and metals	*kg Sb eq.*	Abiotic resource depletion (ADP ultimate reserves)	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.	EC-JRC, 2017	III
Resource use, fossils	MJ	Abiotic resource depletion – fossil fuels (ADP-fossil)	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002	EC-JRC, 2017	III

Table 5 Life cycle impact assessment methods used in the study. Legend for robustness: I, recommended and satisfactory; II, recommended but in need of some improvements; III, recommended, but to be applied with caution; Interim, in development

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