COMPARATIVE LIFE CYCLE ASSESSMENT: EUROPE

JULY 2020

© BALL CORPORATION | 11802 RIDGE PKWY, STE. 200 | BROOMFIELD, COLORADO 80021 | 303-469-3131 | WWW. BALL.COM

STRUCTURE OF THIS PRESENTATION

1

About Life Cycle Assessment

Methodology

Limitations

Circular LCAs

2

sphera

Comparative LCA Study

Carbon Footprint

Circularity Indicator

All indicators Spider graphs

Conclusions

3

Sensitivity Analysis

Recycling Rates

Recycled Content

Lightweighting

Refillables

4

Plans to further improve the beverage can

Carbon footprint opportunities mapping

Why recycling is the biggest opportunity

Why recycling yields matter

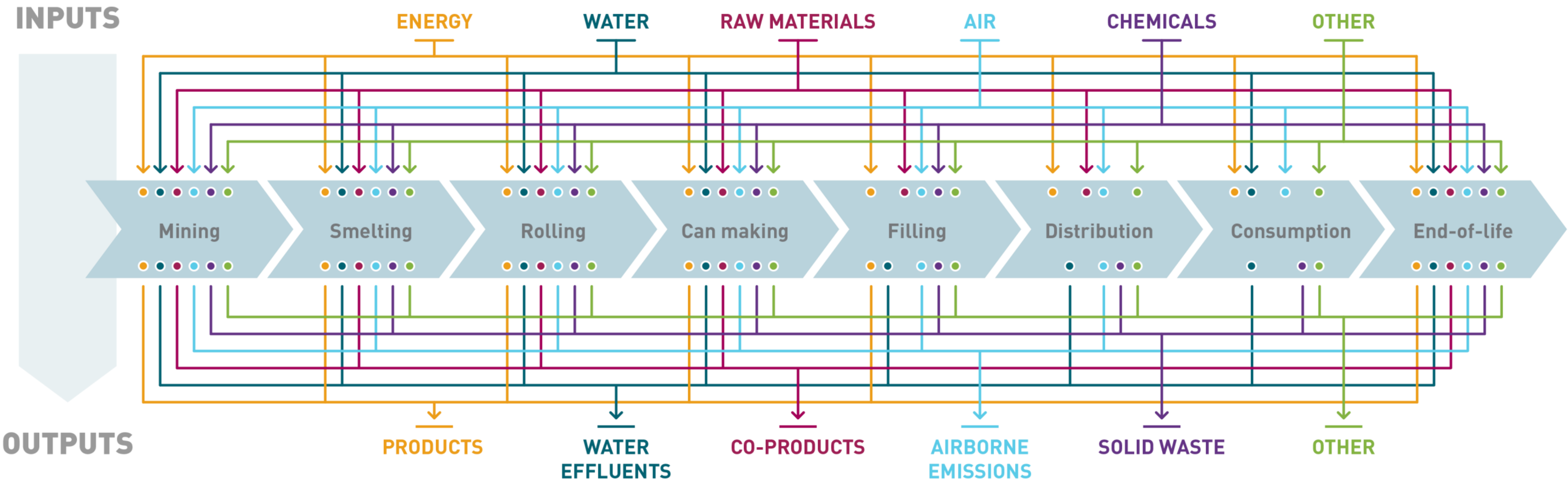
1

About Life Cycle Assessment

WHAT IS LIFE CYCLE ASSESSMENT (ISO 14040 DEFINITION)

LCA is a technique for assessing the environmental impacts associated with a product, by

- Compiling an **inventory** of relevant inputs and outputs of a product system,
- Evaluating the potential **environmental impacts** associated with those inputs and outputs,
- **Interpreting** the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.



Note: LCA schematic for an aluminium beverage can

ENVIRONMENT IMPACT CATEGORIES ASSESSED IN LCAS

While this presentation focuses on Global Warming Potential and some other environmental impact categories (blue squares), the full Sphera LCA considered all categories recommended by Product Environmental Footprint Guidelines.

PURPOSE

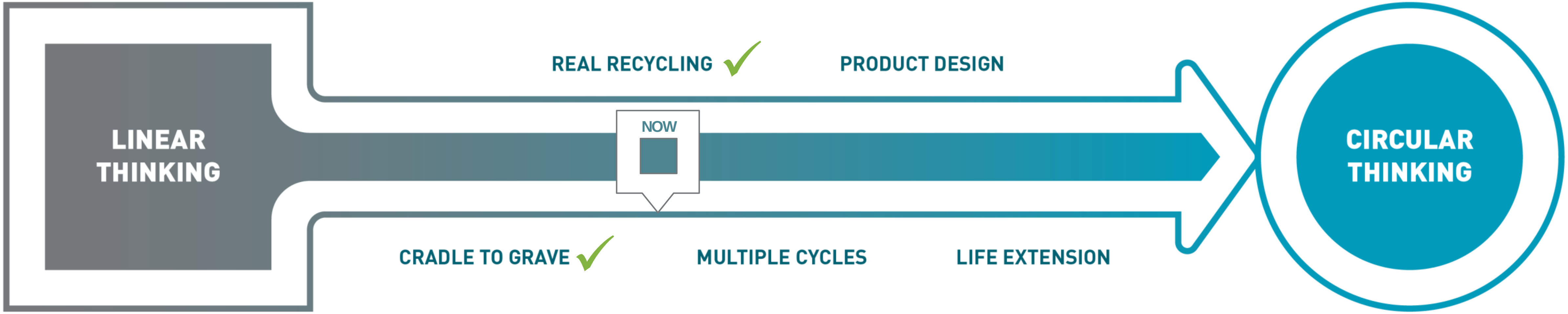
- Identify environmental hotspots along a product's life cycle.
- Add an environmental dimension for decision-makers to explore new design solutions.
- Monitor environmental footprint improvements of a product over time.
- Inform internal decision makers.
- Compare existing products with alternatives.
- Inform and educate external stakeholders, incl. legislators.
- Support product claims.

LIMITATIONS

- Not an exact science (methodologies, models and assumptions shape results).
- For the same product, different LCAs can suggest opposing findings.
- Not the single answer to all environmental questions.
- Circularity, real recycling rates, recycling yields, economics of recycling, and impacts of e.g. microplastics on the environment and human life are not considered in LCAs.
- Describe one specific situation, cannot be generalised for all.

> **A high level of transparency and offering various sensitivity analysis and scenarios in a LCA is important to allow readers to understand the study design, interpret results and draw their own conclusions**

- LCAs today are mostly linear instead of **applying circular thinking**, which would be more appropriate for fast moving consumer goods such as beverage packaging.
- That is why Ball is sponsoring a multi-year PhD program at the University of Barcelona to research limitations of packaging LCAs and develop **new and scientifically sound approaches** to overcome these limitations.
- Ball will build on these findings and **initiate discussions with stakeholders** to ensure future LCAs adequately capture the true sustainability performance of beverage packaging.



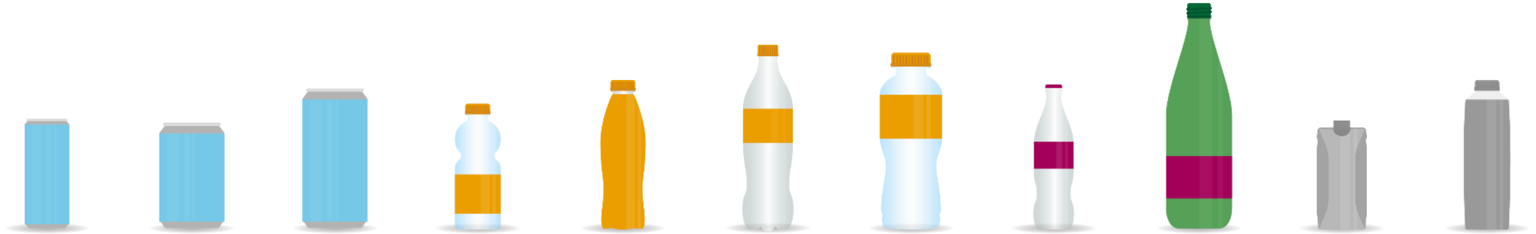
Less representative of FMCG packaging

✓ *Has been explored to some extent in the LCA performed by* sphera

More representative of FMCG packaging

2

Sphera Comparative LCA Study



Critical Peer Review Panel

Prof. Dr. Pere Fullana i Palmer

Director of the UNESCO Chair in Life Cycle and Climate Change

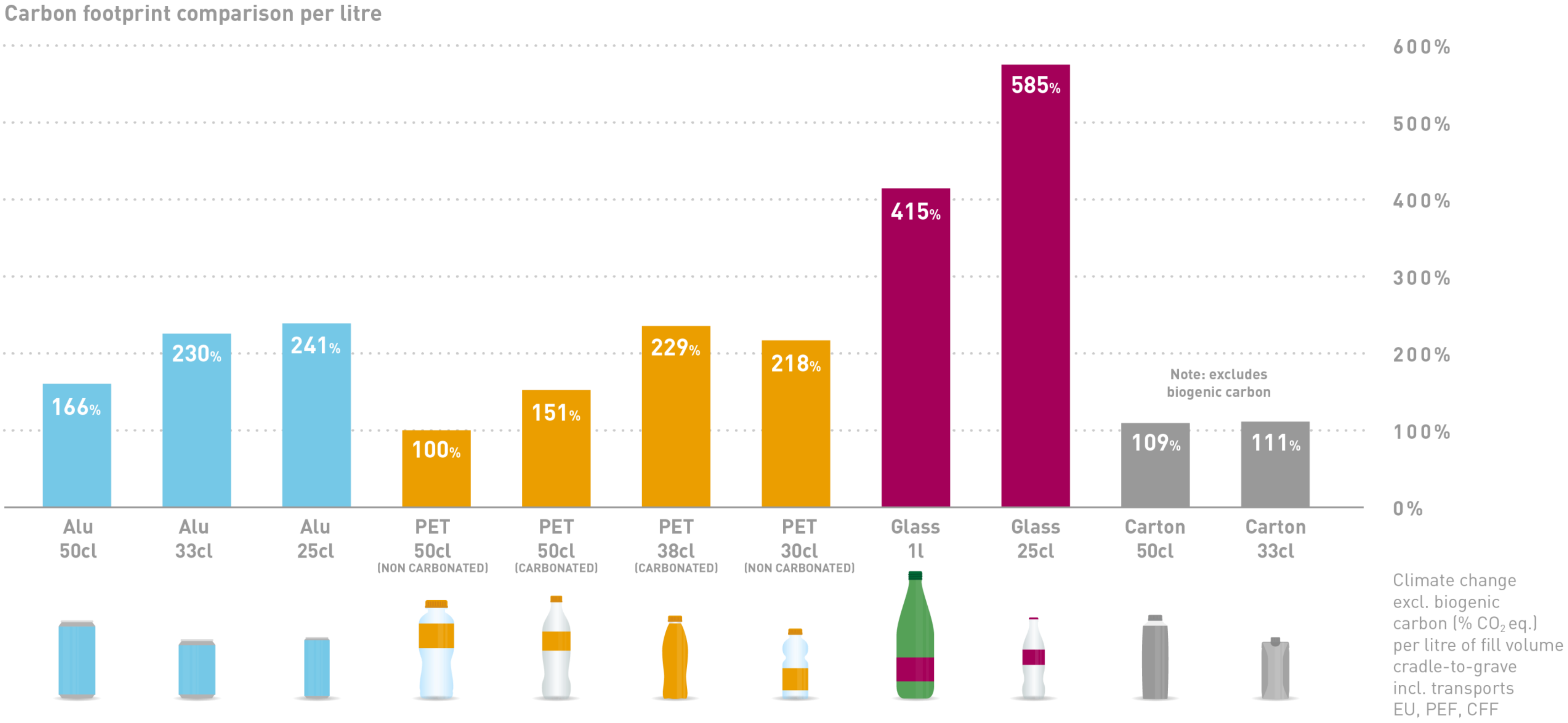
Dr. Ivo Mersiowsky

Sustainability and leadership consultant, LCA expert (focus chemical and plastics industry)

Angela Schindler

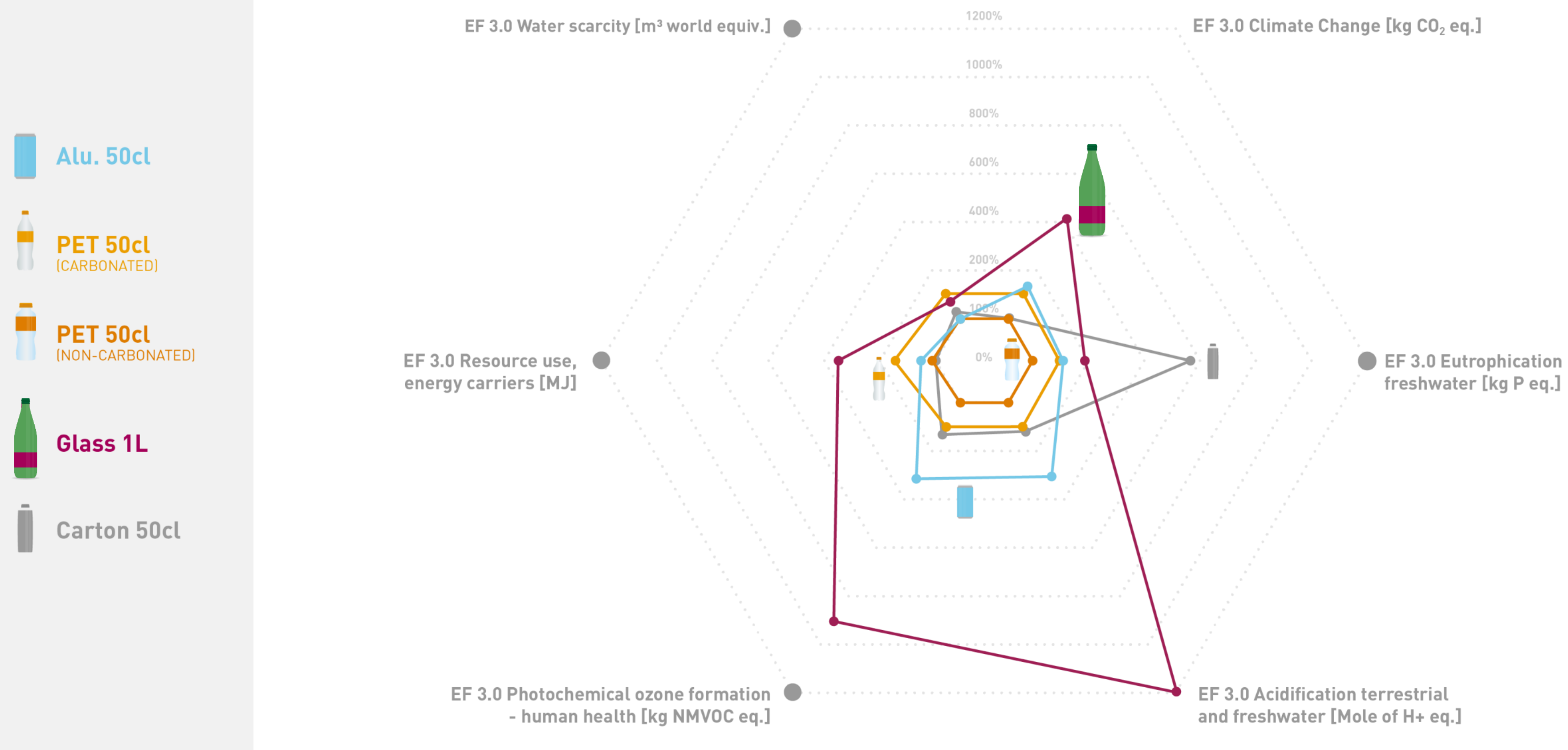
Environmental management consultant, LCA expert (focus modelling, packaging), reviewer for the International Journal of Life Cycle Assessment

GLOBAL WARMING POTENTIAL (CARBON FOOTPRINT) PER LITRE



Source: Peer reviewed comparative beverage packaging LCA, Sphera, 2020. Methodology: EU, PEF, CFF. Comparison per litre.

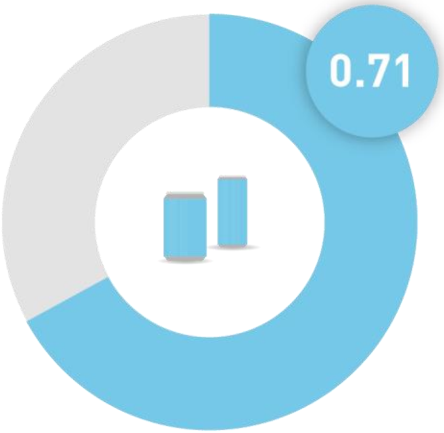
SUMMARY OF SEVERAL ENVIRONMENTAL IMPACT CATEGORIES, BIGGER FORMAT CONTAINERS



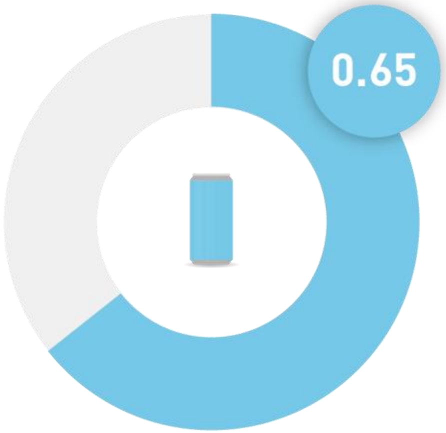
Source: Peer reviewed comparative beverage packaging LCA, Sphera, 2020. Methodology: EU, PEF, CFF. Comparison per litre.

MATERIAL CIRCULARITY INDICATOR (MCI): 0.1 = LINEAR, 1 = FULLY CIRCULAR

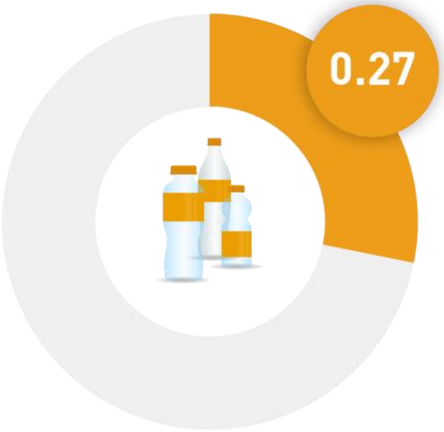
25cl & 33cl aluminium can



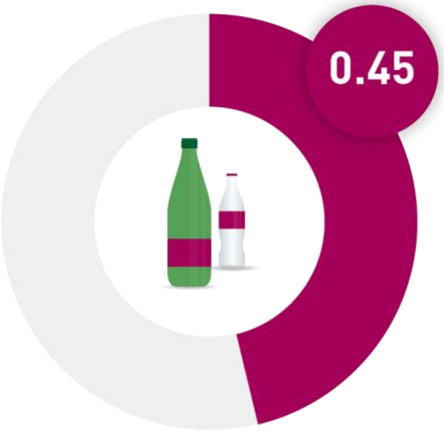
50cl aluminium can



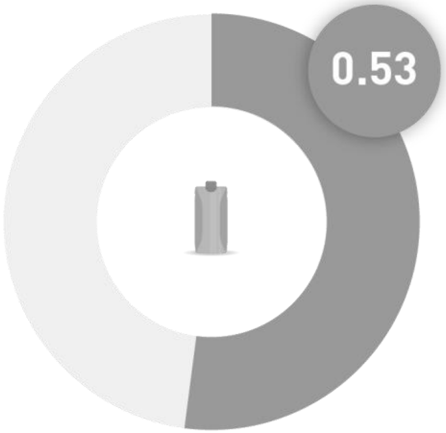
All PET bottles



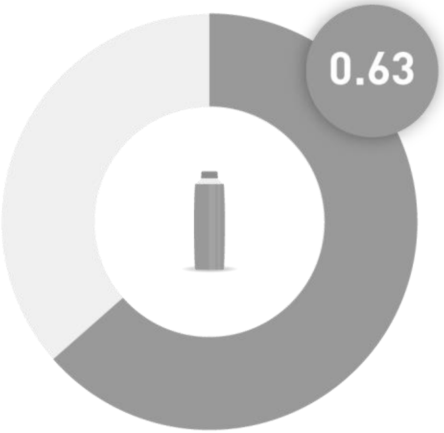
25cl & 1L glass bottle



33cl beverage carton



50cl beverage carton

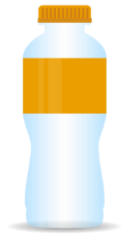


Note: MCI methodology includes non-recycled renewables fibres as circular. Other methodologies do not.

Source: Peer reviewed comparative beverage packaging LCA, Sphera, 2020. Methodology: Ellen McArthur Foundation & Granta Design

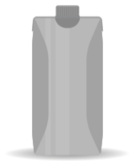
SUMMARY AND CONCLUSIONS FOR EACH MATERIAL

- Good performance on **Global Warming Potential** (GWP), benefiting from lightweight, high recycling rates and good recycled content
- Biggest opportunity to decrease further GWP by **increasing recycling rates and recycled content**, reaching the same values of cartons and non-carbonated water PET bottles (recycling cartons adds GWP impact)
- **Best material circularity score** (~0.7) of all single-use packaging options



- Low weight non-carbonated water PET bottles come with the **lowest overall carbon footprint**, benefiting from the low weight compared to heavier PET bottles for carbonated drinks and other bottles such as tea, juice or premium water
- Carbonated PET bottles and cans **come with very similar carbon footprints** – on other environmental impact categories, sometimes cans come with lower impacts (e.g. resource use), and sometimes PET (e.g. acidification)
- Low real recycling rates (42%) and recycled content (0% as per PEF) as well as high recycling yield losses result in **worst material circularity scores** of all substrates for PET (<0.3)

- **Highest environmental impacts** for single-use glass in several categories, driven by heavy weight, and very resource and energy intensive glass production
- Bad scores on **acidification**
- **Average material circularity** scores for single-use bottles (~0.45)



- Good results for several impact categories driven by biogenic carbon accounting rules and relatively **small manufacturing impacts** and the fact that integrated pulp and paper mills generate most of their energy from biomass intake such as wood offcuts
- **Material circularity scores** in the 0.5-0.6 range, benefiting from the MCI methodology which assumes all sustainably sourced fibers are restorative and circular by nature (despite recycling challenges of fiber, plastic and aluminum layers)

Source: Ball summary analysis based on the peer reviewed comparative beverage packaging LCA, Sphera, 2020

PRODUCT SPECIFICATIONS & MAIN DATASETS USED. ALL CONTAINERS ARE REAL, POPULAR BEVERAGES

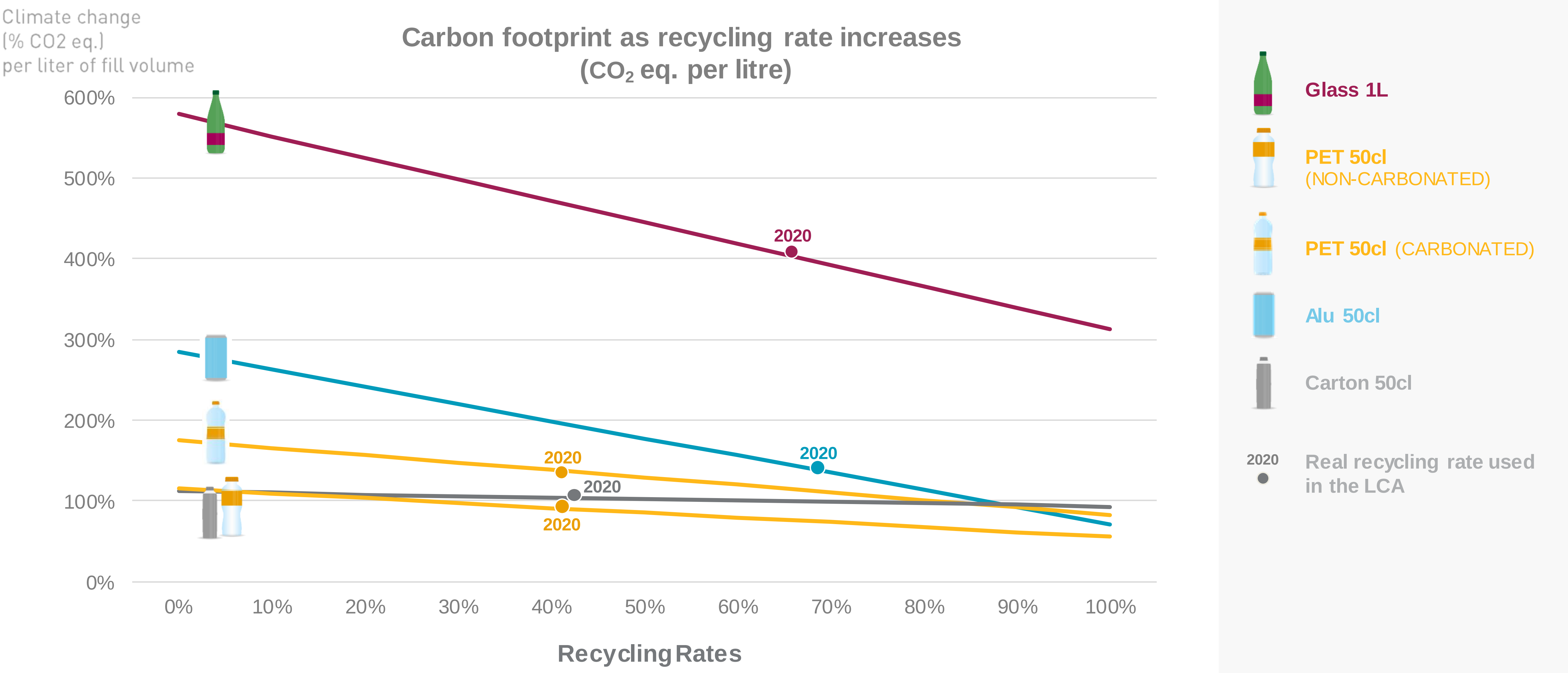
	Alu 50cl	Alu 33cl	Alu 25cl	PET 50cl (non-carbonated)	PET 50cl (carbonated)	PET 38cl (carbonated)	PET 30cl (non-carbonated)	Glass 1L	Glass 25cl	Carton 50cl	Carton 33cl
Purchased in	DE	DE	UK	UK	DE	UK	UK	UK	DE	DE	UK
Total Container Weight *(g)*	14.5	11.9	10.3	14.9 (bottle, cap, label)	22.5 (bottle, cap, label)	27.2 (bottle, cap, label)	20.9 (bottle, cap, label)	521 (bottle, cap, label)	172 (bottle, cap)	23.0	17.0
Secondary Packaging	12 pack, corrug. board, LDPE (60g)	4 pack, corrug. board, LDPE (51g)	4 pack, corrug. board, (28.5g)	12 pack, LDPE (16g)	12 pack, LDPE (16g)	6 pack, LDPE (8g)	Individual bottle	6 pack, HDPE crate (1042g)	4 pack, corrug. Board (44g)	8 pack, corrug. board (126g)	4 pack, corrug. board (20g)
Recycled Content*	55% can body, 3% can end			0%				40%		0%	
Recycling rate*	69% (real recycling)			42% (real recycling)				66% (real recycling)		43% (collection rate!)	
Allocation factor*	0.2			0.5				0.2		0.2	
Main Datasets	Primary & secondary aluminum, sheet rolling: EA 2015			PET granulate, blow moulding: GaBi 2016				Virgin & recycled glass: GaBi 2016		Liquid packaging board: ACE 2014	

**all values as per PEF Guidelines, Annex C. Official collection for recycling rates are revised to real recycling rates as per information from each association except for cartons who do not publish it.*

3

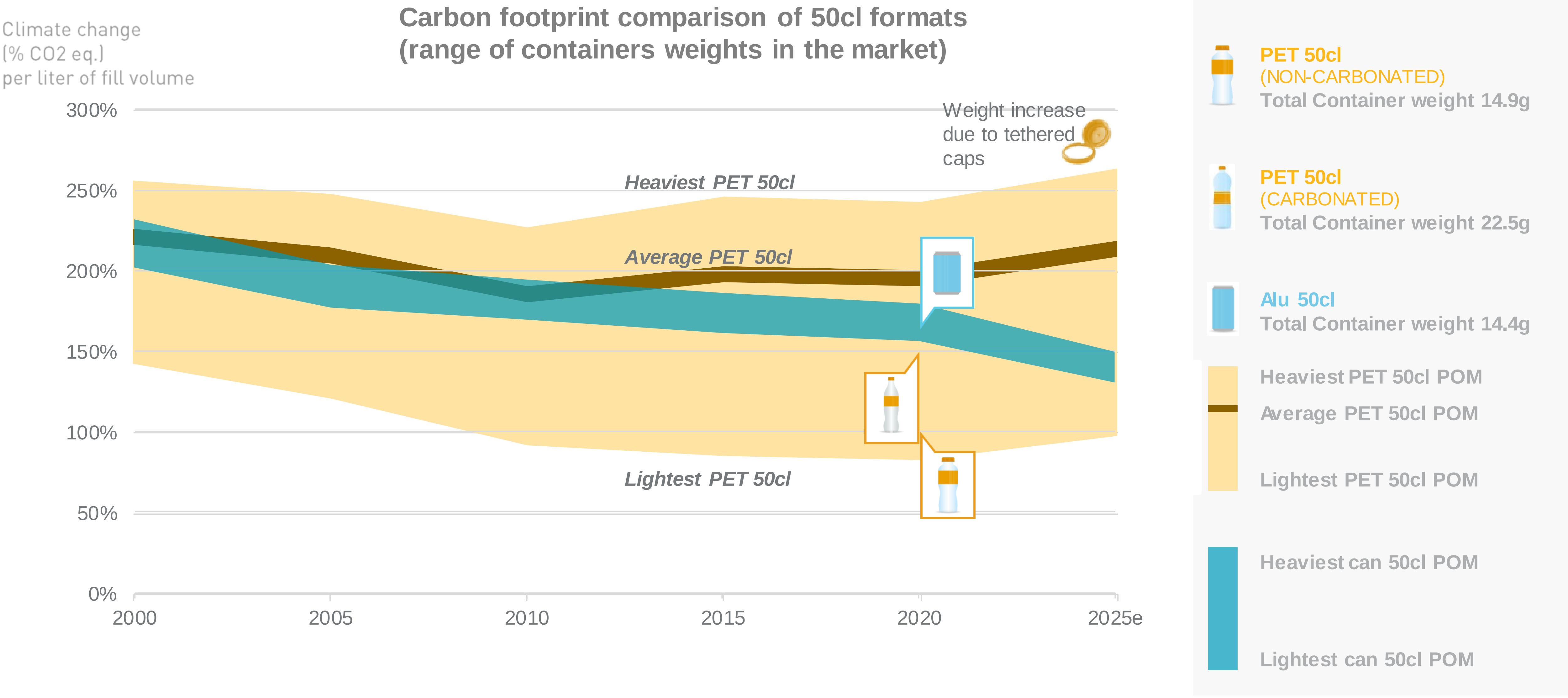
Sensitivity Analysis

EFFECT OF RECYCLING RATE ON CARBON FOOTPRINT



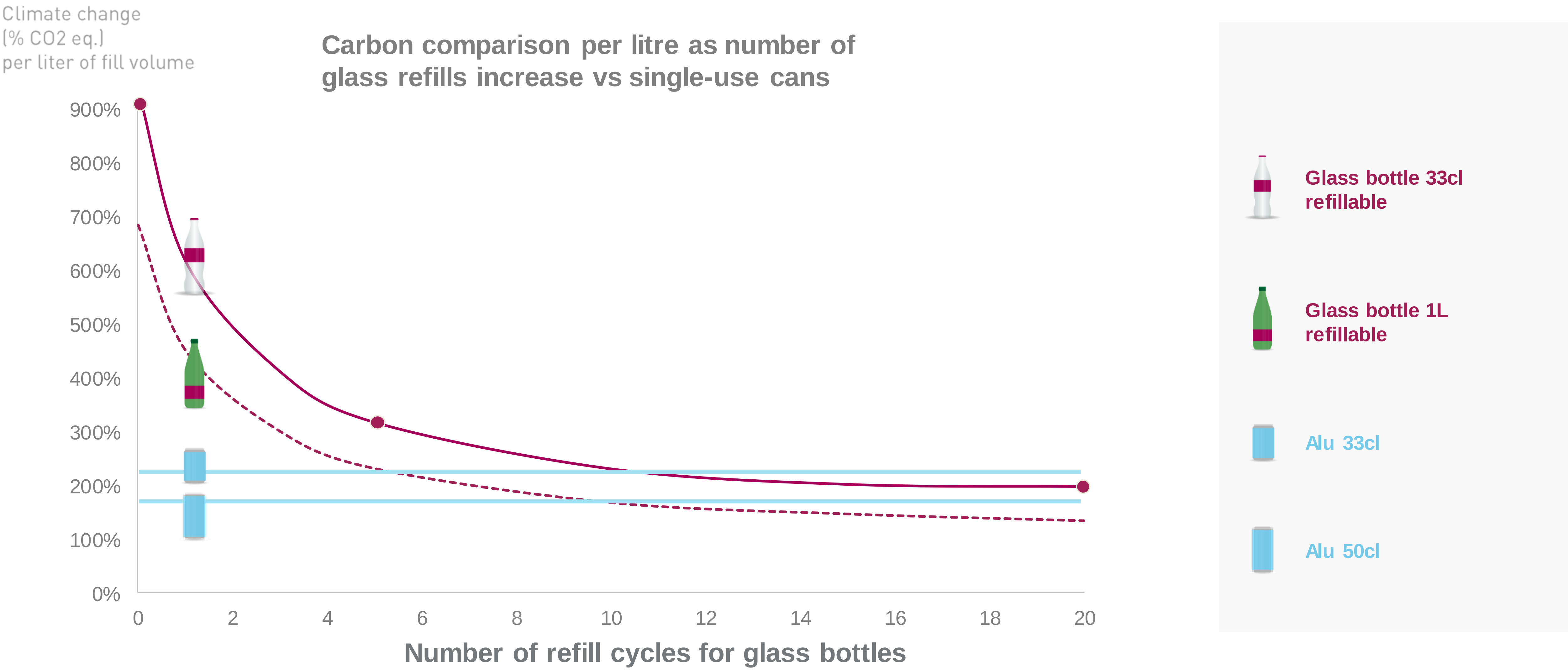
Source: Ball's graph based on the sensitivity data from peer reviewed comparative beverage packaging LCA, Sphera, 2020. The PEF CFF formula is too rigid for this sensitivity assessment, so the substitution method has been used as the baseline for this analysis.

EFFECT OF LIGHTWEIGHTING TRENDS FOR 50CL PET AND CANS ON CARBON FOOTPRINT



Source: Average weights from INCEPT. Ball's graph using Incept weights and LCA data consistent with Sphera, 2020.

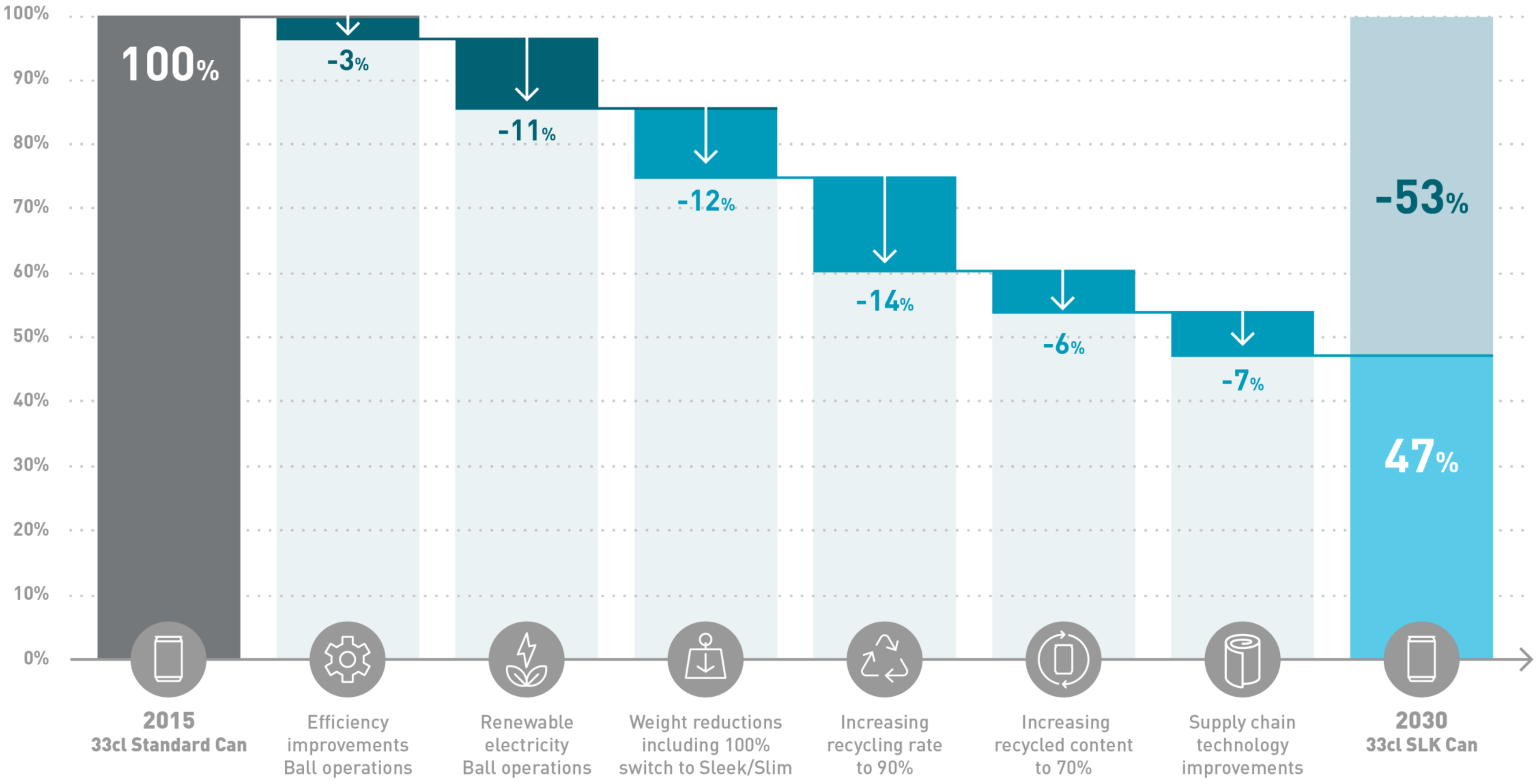
EFFECT OF REFILL CYCLES OF REFILLABLES GLASS BOTTLES ON CARBON FOOTPRINT



Source: Ball's graph based on the sensitivity data from peer reviewed comparative beverage packaging LCA, Sphera, 2020 for 33cl and 50cl.
1L Glass bottle sensitivity analysis was not included in the Sphera report and has been calculated by Ball at later stage.

4 Plans to further improve the beverage can

IDENTIFIED OPPPORTUNITIES TO DECREASE A 33CL CAN'S CARBON FOOTPRINT IN NEXT 5-10 YEARS (33CL)



Source: Ball's own calculation based on Instant LCA software and own and industry data.

100% COLLECTION

100% RECYCLED CONTENT BACK INTO SAME VALUE PRODUCTS

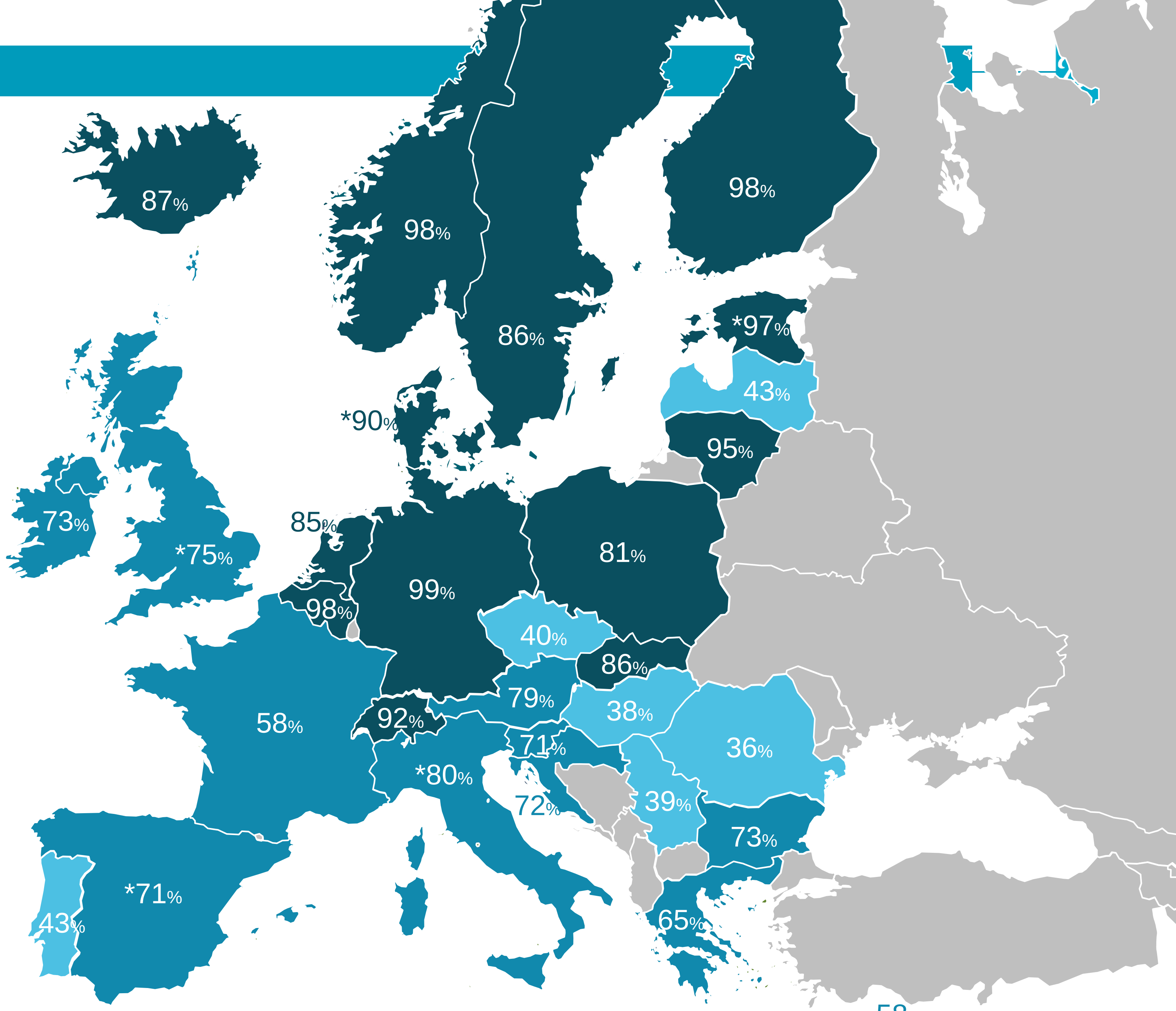
100% OF THE MATERIALS ARE SORTED

100% YIELD RECYCLING

CURRENT RECYCLING RATES IN EUROPE

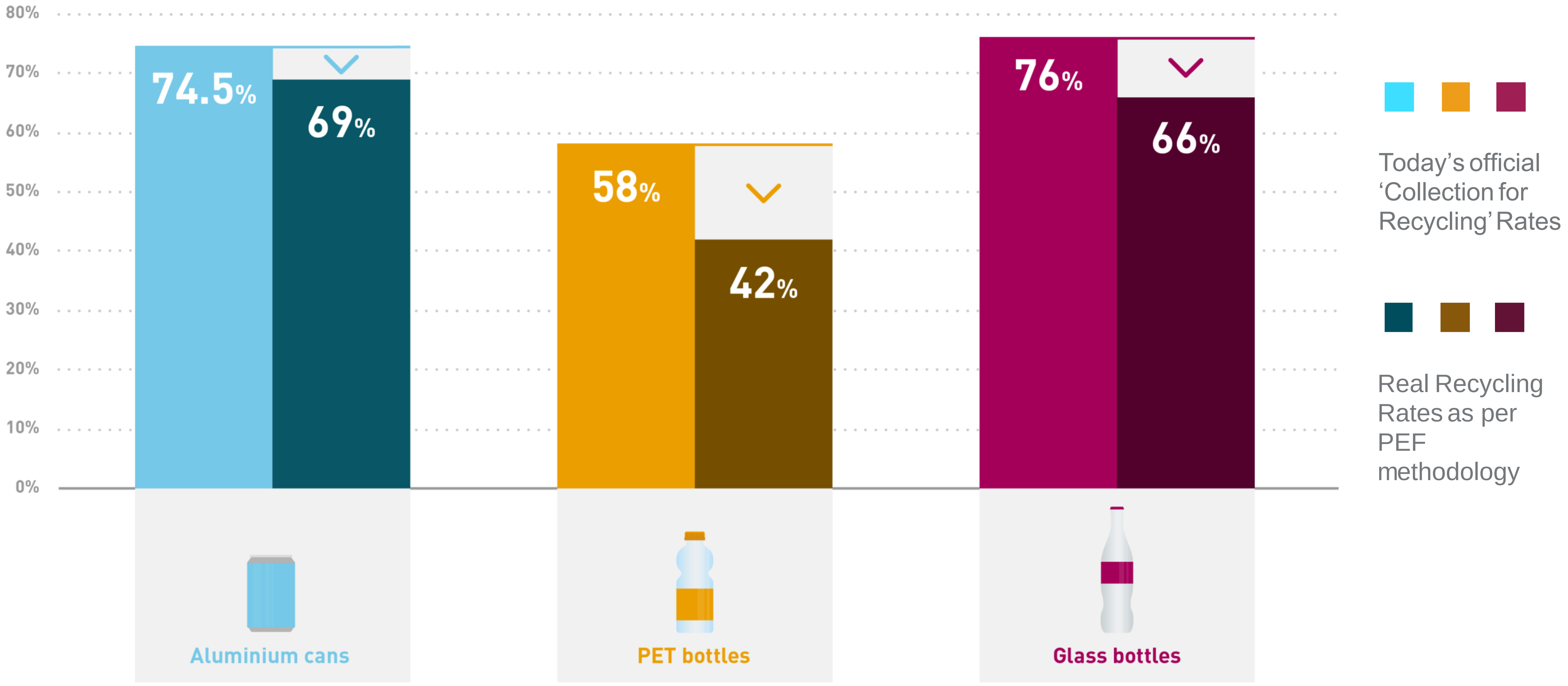
74.5%

The overall recycling rate for aluminium beverage cans in the European Union, Switzerland, Norway and Iceland increased to a new record level of 74.5% in 2017.



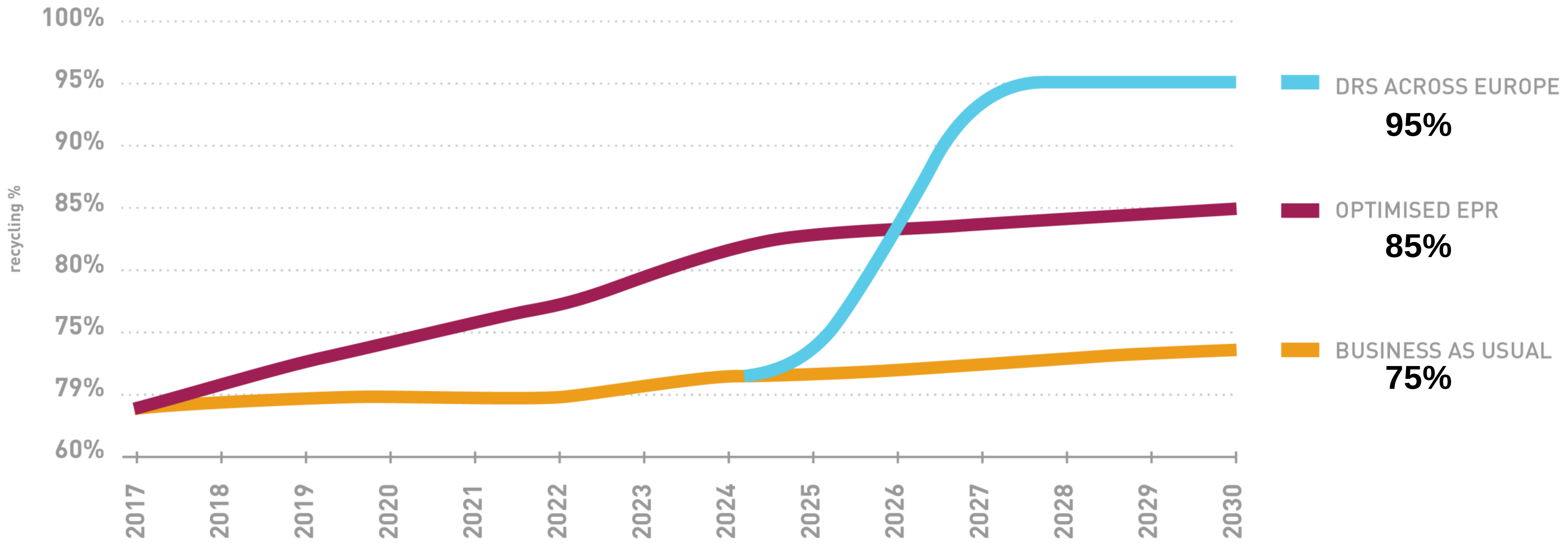
Source: European Aluminium & Metal Packaging Europe 2017 recycle rates. * 2018 locally reported rates.
Bulgaria and Slovakia only report overall metal packaging recycling rates.

LIKELY DROP OF RECYCLING RATES WITH NEW EU CALCULATION POINT



Source: collection rate from each association: aluminium cans (MPE), PET (PETCORE), glass (FEVE), Real recycling rates are calculated as the ratio between the R2 factor of the PEF discussions (output recycling plant [R2], that can be download here) and the collection rate for the aluminium can, PET bottle and glass bottle.

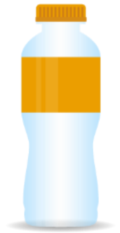
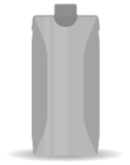
DRS AND OPTIMISED EPR WILL PUSH THE COLLECTION RATE IN EUROPE BEYOND 90% BY 2030



Development of recycling schemes over the next years

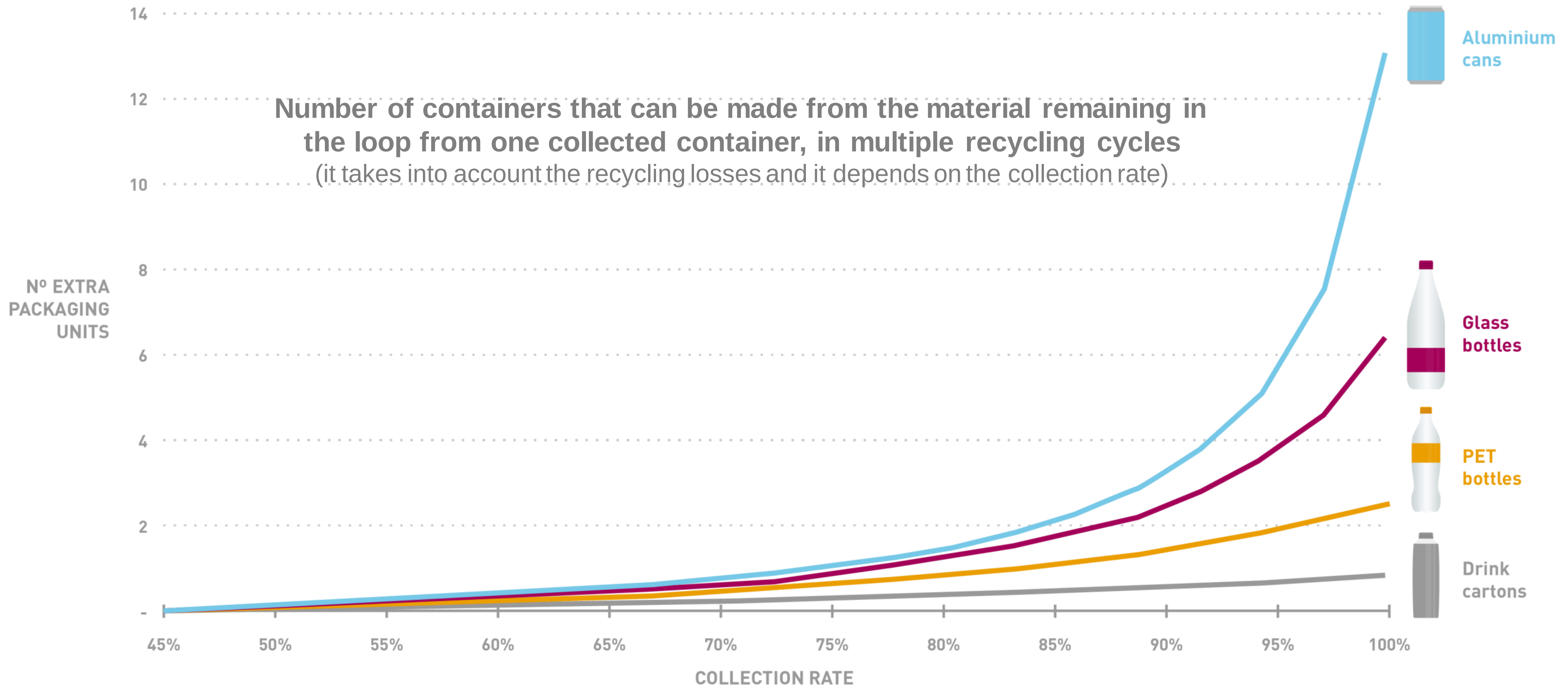
Source: FFACT - Aluminium beverage can recycling rate forecasts for 2025 and 2030

ISSUES ACROSS ALL RECYCLING VALUE CHAIN FOR VARIOUS BEVERAGE CONTAINERS

	Collection	Sorting	Extra Sorting	Treatment	Re-incorporation
	• Weight • Breaks	• Colour • Breaks	• Fine particles		• Low value
	• Minimum collection rate	• Black plastics • Coloured PET • Export market	• Cap, silicone valve, glue, label	• Opaque / TiO_2 • High yield losses • Degradation • High cost	• Nurdles • Minimum rPET content • EFSA guidelines
	• Contamination to paper and cardboard • Low value	• Lack of infrastructure	• Cap, straw, straw packaging	• Multi-material • High yield losses • PolyAl • Fibre shortening	• End markets
				• Non-aluminium labels, ends, widgets	

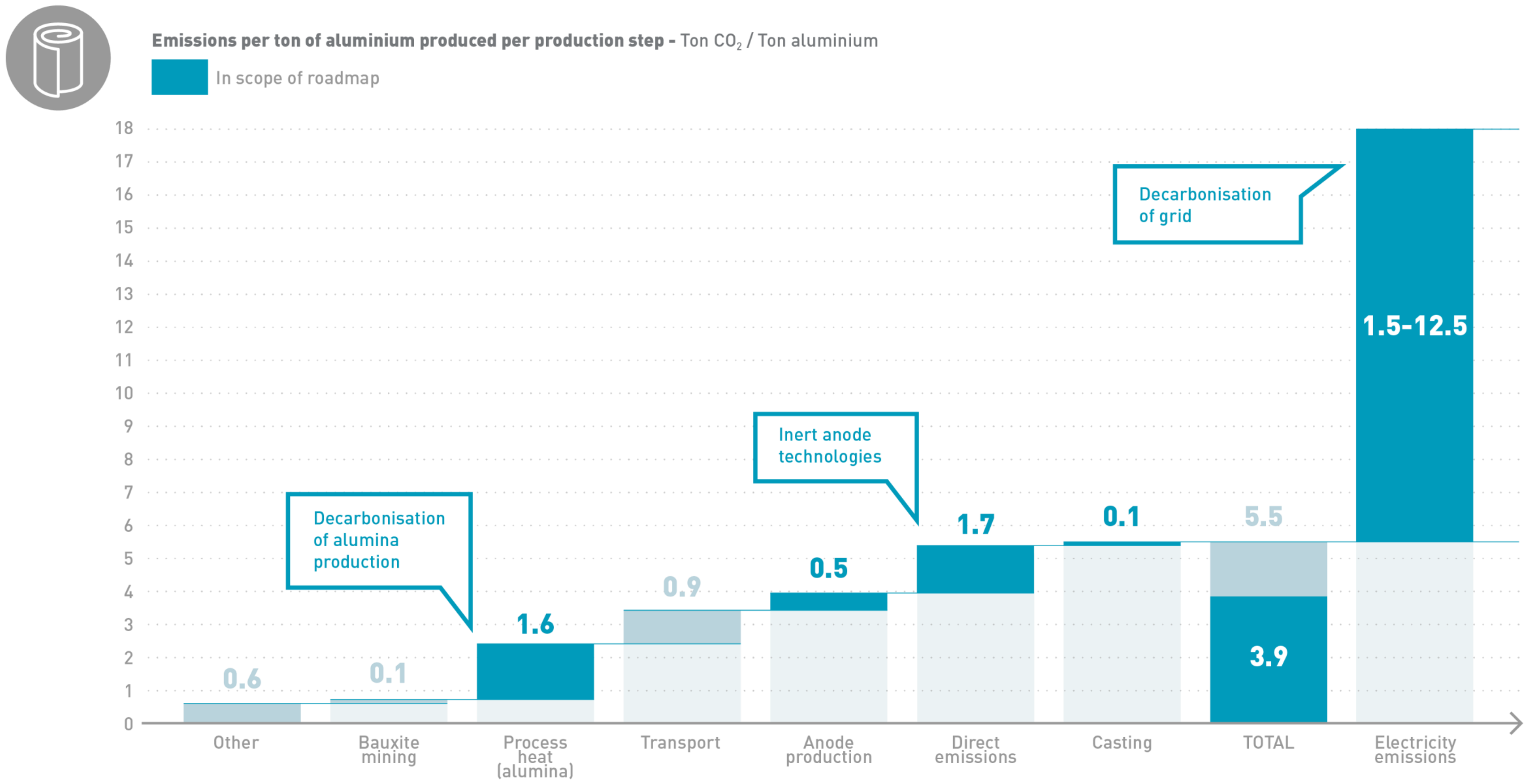
Source: Ball's own analysis based on experience and interview with various consultants and recycling experts

MATERIAL KEPT IN THE LOOP AS COLLECTION INCREASES: EFFECT OF RECYCLING YIELDS IS WHAT MATTERS



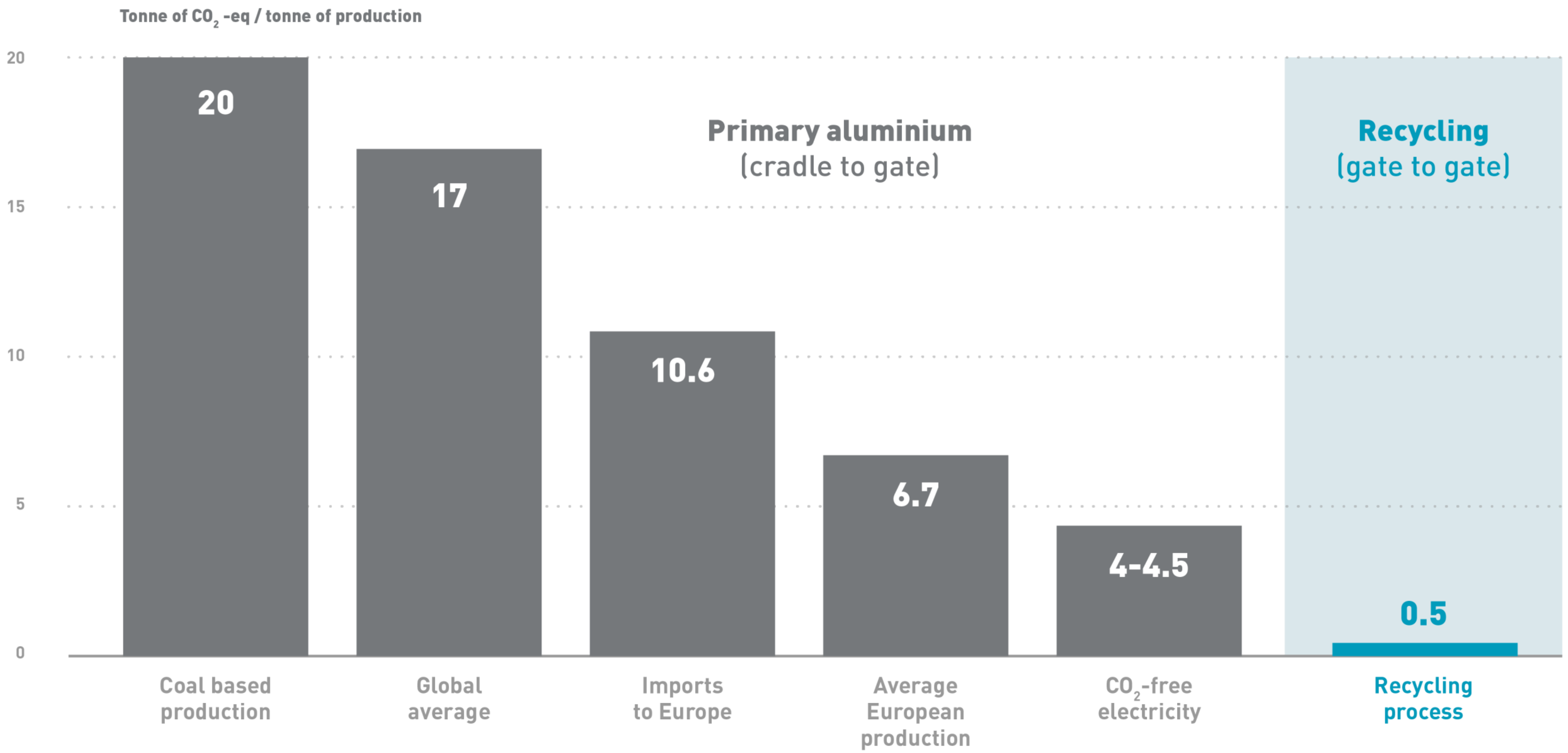
Source: Eunomia's original idea. Ball's own analysis based on recycling yields assumptions for each packaging container. Real recycling yields are calculated as the ratio between the R2 factor of the PEF discussions (output recycling plant [R2], that can be download here) and the ´collection for recycling´ rate for the aluminium can, PET bottle and glass bottle.

FURTHER OPPORTUNITIES TO DECREASE CARBON FOOTPRINT OF VIRGIN ALUMINIUM



Source: *Material Economic analysis via data from International Aluminium Institute, 2019 (http://www.world-aluminium.org/statistics/)*

IMPACT OF VARIOUS VIRGIN ALUMINIUM SEMI-FINISHED GOODS COMPARED WITH RECYCLING



Source: European Aluminium Circular Action Plan, 2020 https://www.european-aluminium.eu/media/2906/european-aluminium-circular-aluminium-action-plan.pdf)

THANK YOU

Questions?