

# Not all pollutants are plastic.

*Insights from the Life Cycle Assessment of PET*

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ABIPET



Realization:

Instituto  
**SustenPlást**

# AGENDA

**1** The Brazilian market for  
PET resin and recycled  
PET

**2** Charting the Evolution of  
PET Recycling

**3** Life Cycle Assessment  
PET Life

# ABIPET: Few members, but high representation

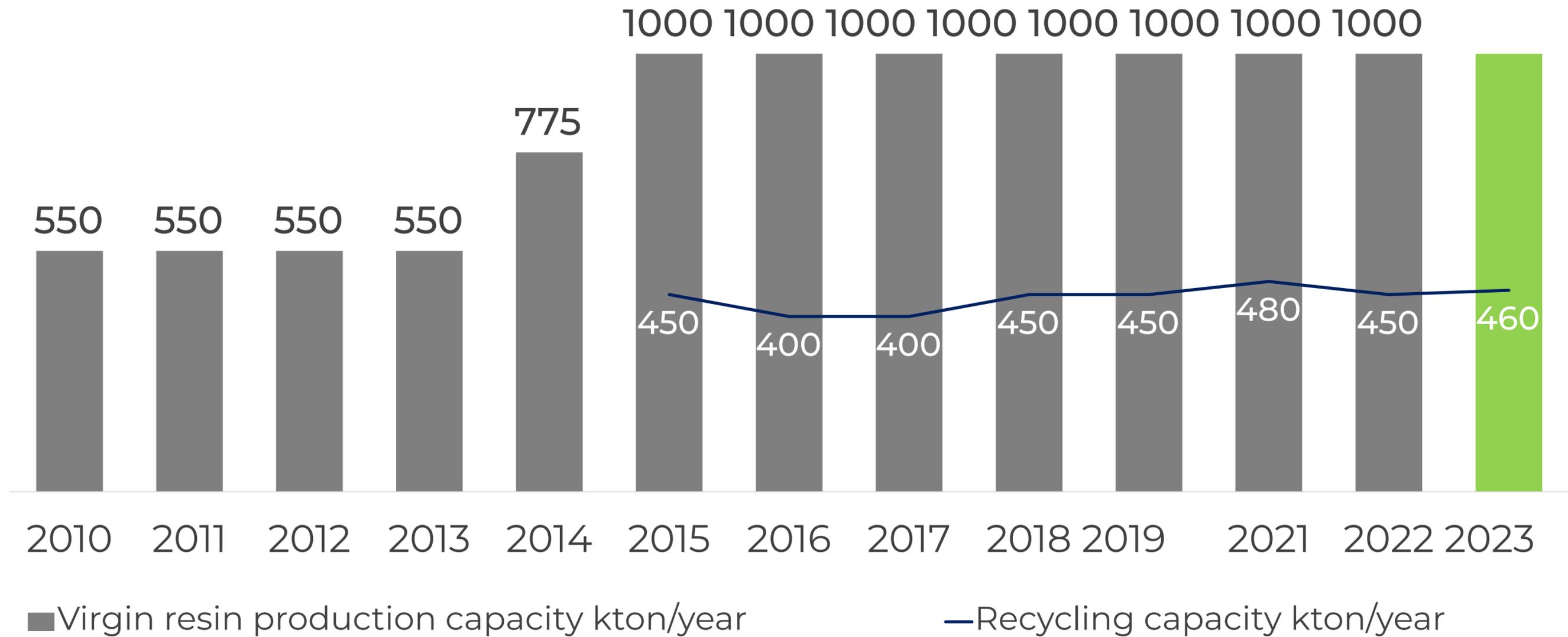
**PET resin**  
**100%**

**Transformation**  
**75%**

**Recycling**  
**80%**

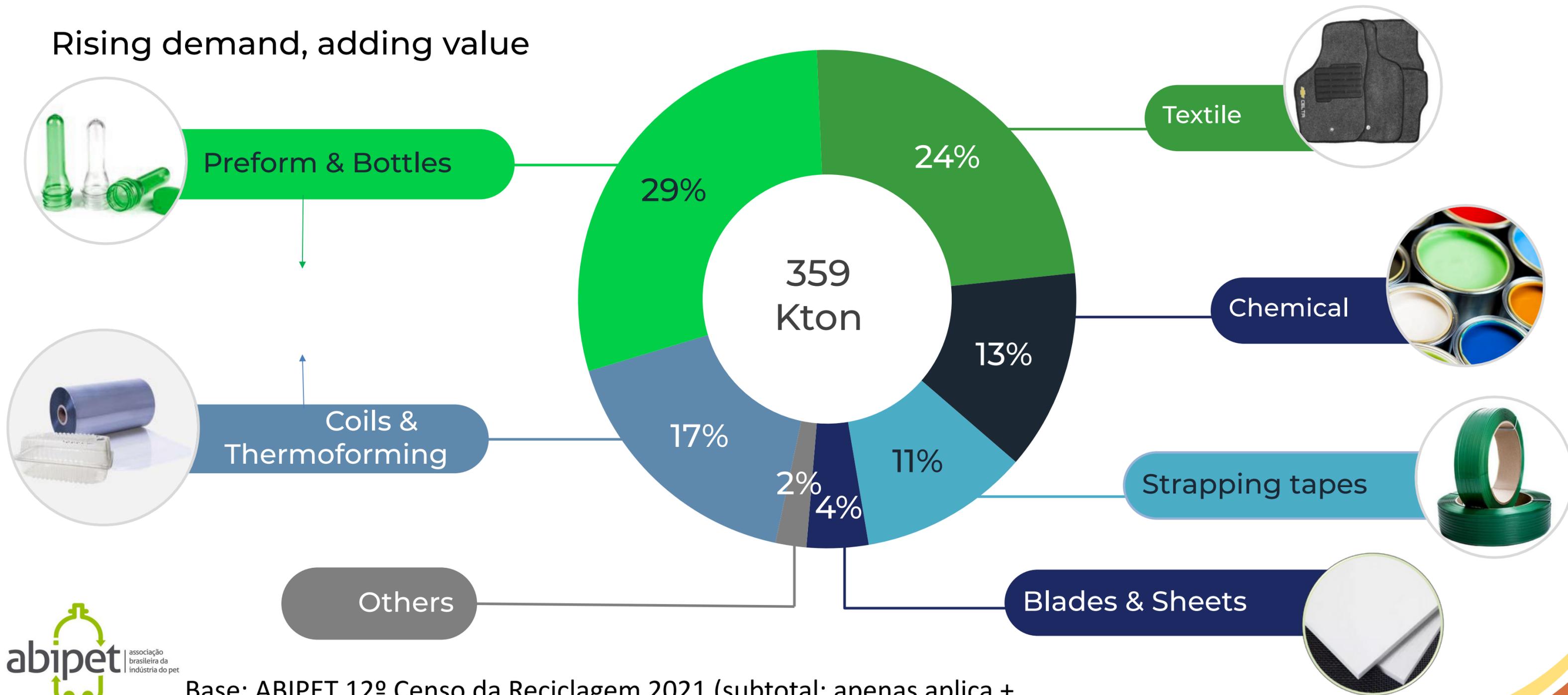


# Installed capacity of PET resin in Brazil (Kton)



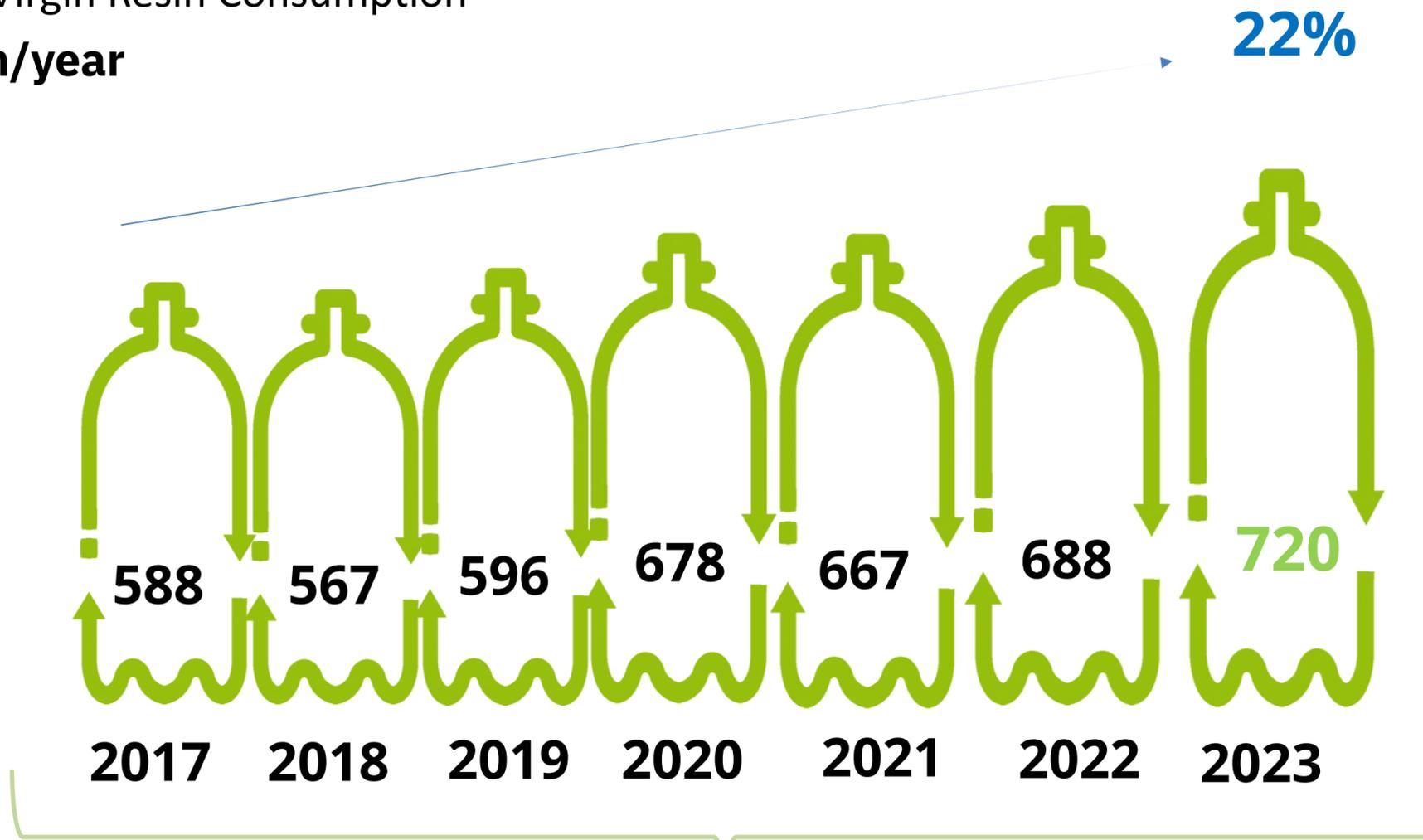
# Applications of recycled PET

Rising demand, adding value



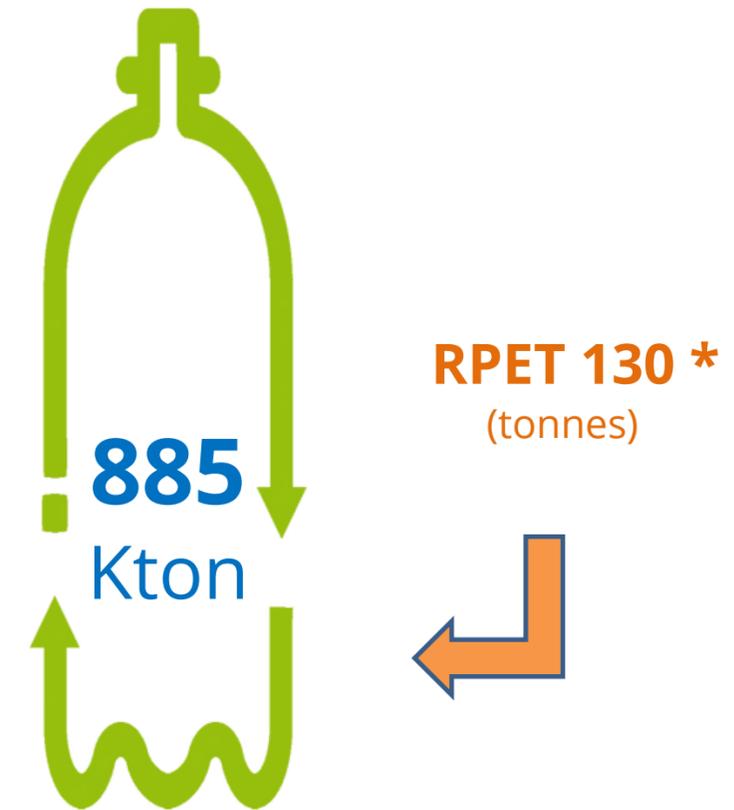
# Brazilian virgin (VPET) and recycled (RPET) PET market

PET Virgin Resin Consumption  
Kton/year



Total Growth = 31%  
VPET + RPET 165 Kton

RPET Bottle Grade



Growth in number of bottles  
~ 58%

Bottles weight reduced 23% (avg) during this period

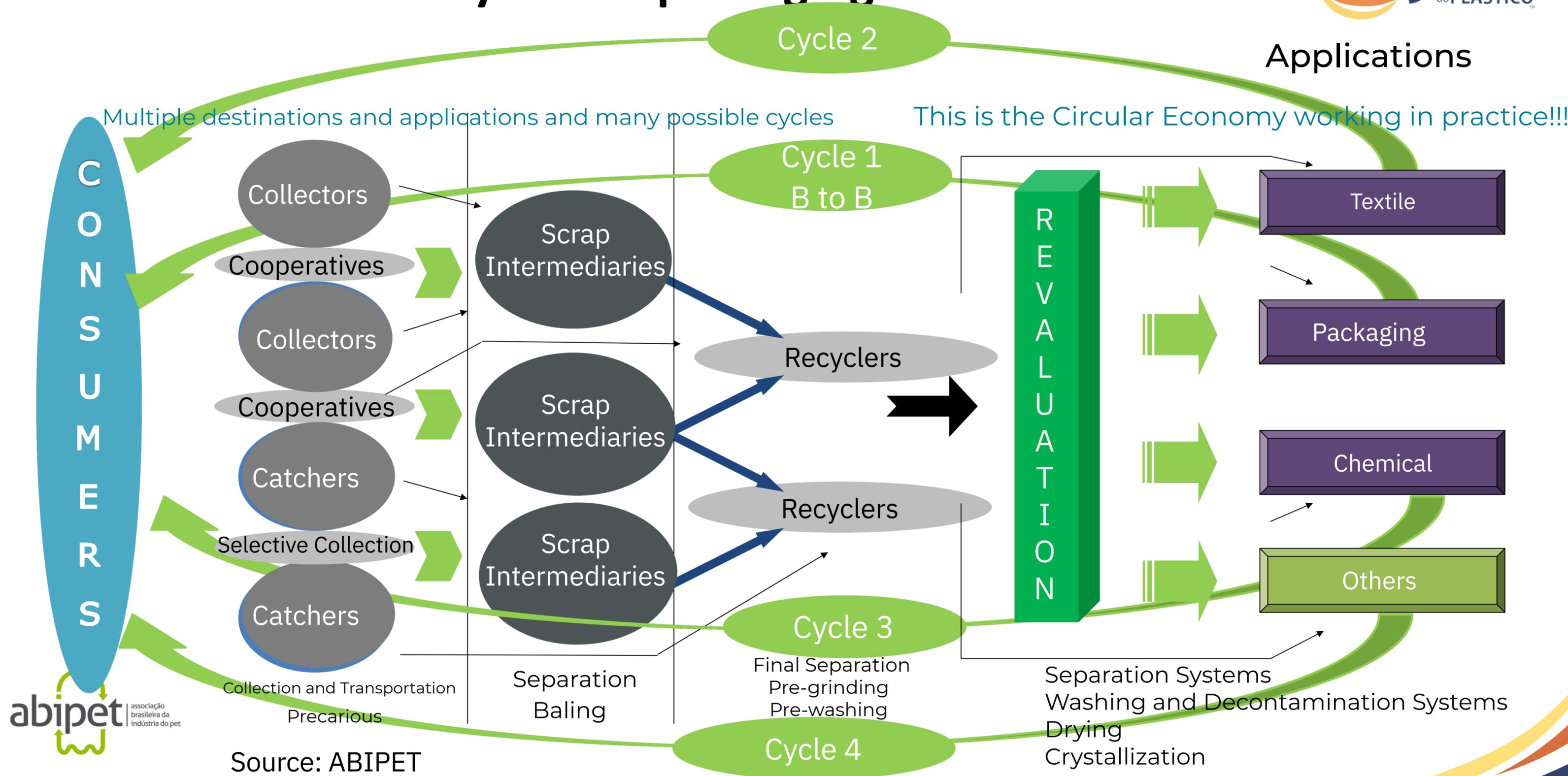


Source: ABIPET/ MDIC (Comexport) | Kton = 1000 tons.

# AGENDA

- 1 Brazilian VPET and RPET Market
- 2 Charting the Evolution of PET Recycling
- 3 PET Life Cycle Assessment

# The real circularity of PET packaging in Brazil



# Packaging Design Makes All the Difference: Design for Environment

According to recycling companies, **colors** and **labels** can reduce the attractiveness of a packaging for recycling



1st

Colored packaging (other than blue and green)



2nd

Bottles with label (PVC or PET)



3rd

Silk-printed packaging



4th

Edible oil packaging



5th

Packaging with fully labeled glued

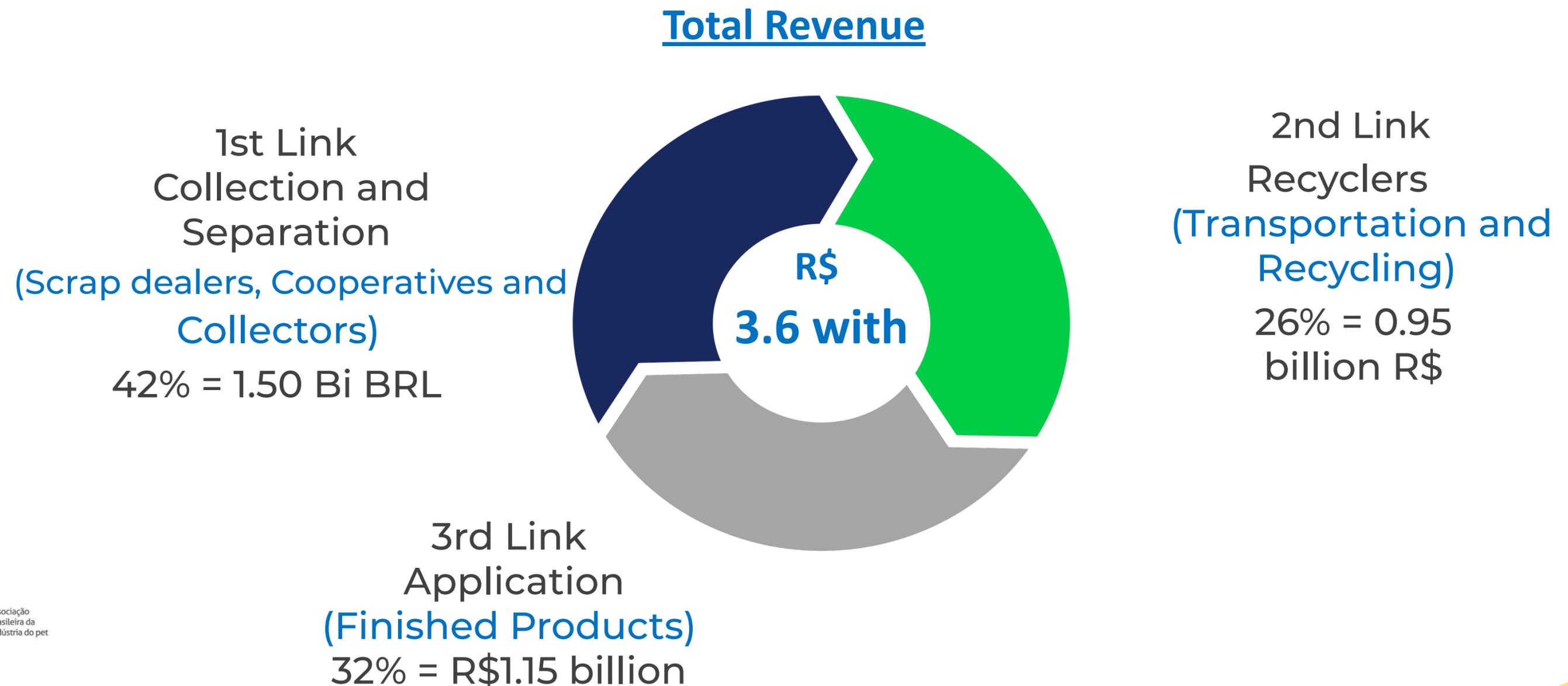


6th

Packaging with metallic labels

# Economic Distribution of Revenue from PET Bottle Recycling

Reverse logistics generates employment, income and also contributes to the environment.



# AGENDA

1

Brazilian Market  
of VPET and RPET

2

Packaging Design  
as an inducer for  
technological  
development

3

PET Life Cycle  
Assessment

# Study creators and technical staff



**ABIR**  
Associação Brasileira das Indústrias de Refrigerantes e de Bebidas não Alcoólicas



**Critical reviewers Prof. Dr. Elen B. A. Vasques Pacheco – UFRJ Prof. Dr. Carlos A. Rodrigues Anjos – UNICAMP**



# Aim

Develop a **Life Cycle Assessment** (LCA) study of the most commonly used liquid food packaging in Brazil, taking a **cradle-to-grave** approach to **identify the option with the best environmental performance**, as well as potential opportunities for improvement.

**Note 1:** The study follows the principles defined in the **ISO 14044** standard. The following materials were considered in this study, in a total of 11 packages (base year 2021).

**Note 2:** This comparison is aimed at Abipet and partner associations and remains for **restricted use**.



# Objective and scope

## Function of packaging

Packaging liquid foods, maintaining their physical and chemical characteristics to meet the product's expiration date under usual conditions in Brazil, considering household consumption and the **base year of 2021 in terms of supply raw material and final destination.**

## Functional unit

Store **1 liter of liquid food**, maintaining its physical and chemical characteristics to meet the product's expiration date under normal conditions in Brazil.

# ICV – Life Cycle Inventory, the basis for evolution

TABELA 4. ICV dos três tipos de GARRAFAS de PET em estudo. Unidade funcional: 1 t de garrafas.

Parâmetro	Unidade	Quantidade		
Entradas		Garrafa de PET de 2 L para refrigerante (29% rec.)*	Garrafa de PET de 500 mL para água mineral (virgem)	Garrafa de PET de 900 mL para óleo comestível (virgem)
<b>Consumo de recursos naturais</b>				
Petróleo	kg			
Gás natural	kg			
Biomassa	kg			
Água	m <sup>3</sup>			
<b>Consumo de energia</b>				
Total	MJ			
Energia de recursos não-renováveis	MJ			
Energia de recursos renováveis	MJ			
<b>Saídas</b>				
<b>Emissões para o ar</b>				
Amônia	kg			
CO <sub>2</sub>	kg			
CO <sub>2</sub> (biótico)	kg			
CO <sub>2</sub> (mudança de uso de terra)	kg			
CO	kg			
CO (biótico)	kg			
NOx	kg			
N <sub>2</sub> O	kg			
Metano	kg			
Metano (biótico)	kg			
<b>Emissões para a água</b>				
DBO	kg			
DQO	kg			
Zinco <sup>2+</sup>	kg			
Ácido (calculado como H <sup>+</sup> )	kg			
Água oleosa	kg			
Amônia	kg			
Nitrato	kg			
Fosfato	kg			
Hidrocarbonetos	kg			
Efluente líquido	kg			
Sólidos suspensos	kg			
<b>Emissões para o solo</b>				
Resíduos de processos industriais	kg			
Resíduos de PET** (reciclagem)	kg			
Resíduos de embalagem*** (reciclagem)	kg			

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## Study Representativeness (Total Brazilian Market)

- ✓ Packaging and Distribution: 75% to 80%
- ✓ Resin Production: 100%
- ✓ Preform Bottle: > 75%
- ✓ Recycling: > 80%

Imported products were considered based on ECOINVENT – the most widely used database for LCA.

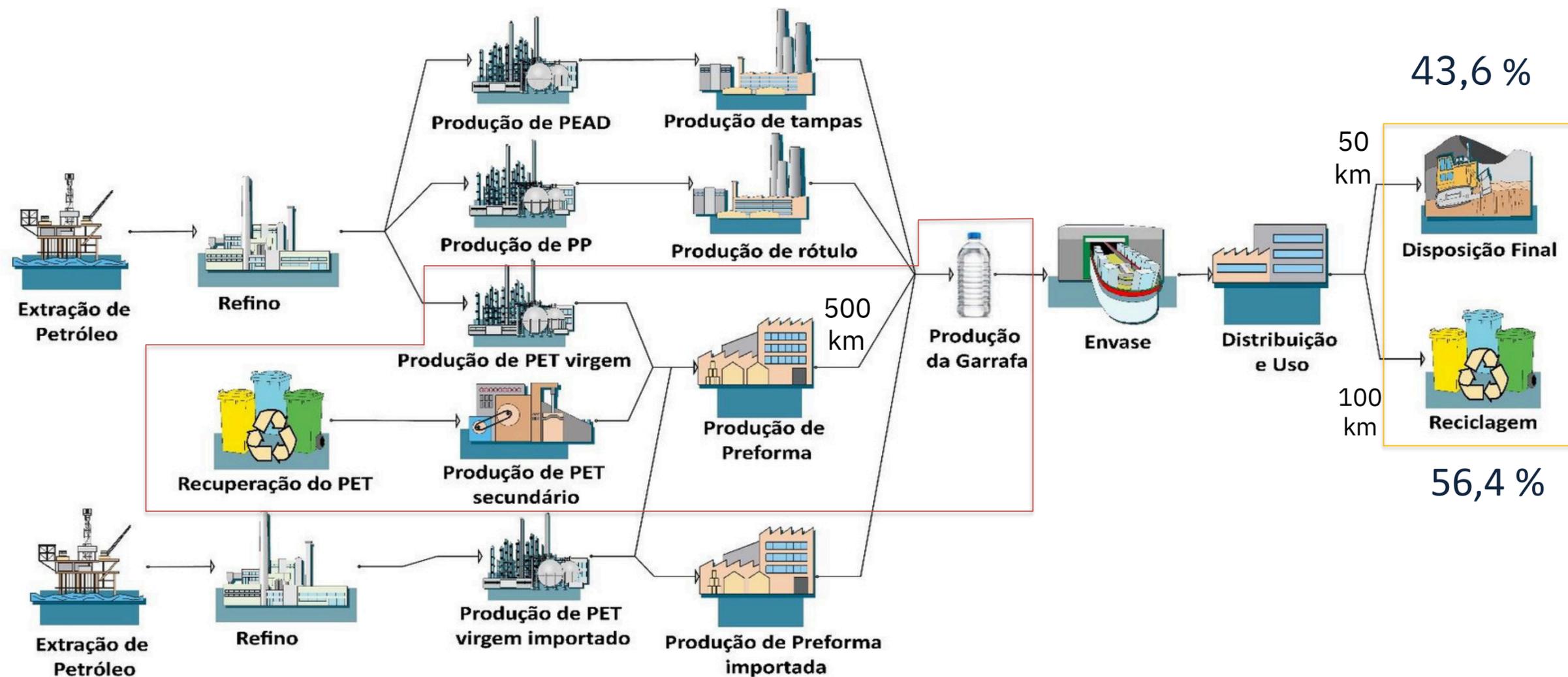
# Companies that collaborated



# Reference flow

Application	Raw material	Packaging volume	Reference Flow (number of packages/Liter)
<b>Water Packaging</b>	PET	500ml	<b>2,00</b>
		1500 mL	<b>0,67</b>
	Aluminum	350 mL	<b>2,86</b>
	Glass	300mL, non-returnable	<b>3,33</b>
<b>Soft Drink Packaging</b>		250 mL	<b>4,00</b>
	PET	600 mL	<b>1,67</b>
		2000 mL	<b>0,50</b>
	Aluminum	350 mL	<b>2,86</b>
	Glass	250mL, non-returnable	<b>4,00</b>
<b>Oil packaging kitchen</b>	PET	900 mL	<b>1,11</b>
	Steel	900 mL	<b>1,11</b>

# Production system: PET bottle



Distances traveled: 275 km (refrigerant)  
 407 km (water)  
 795 (oil)

# Life Impact Assessment

The method is based on the recommendation proposed by the European Commission within the context of the Environmental Footprint (EF) initiative. 12 impact categories were considered:

CATEGORY	DESCRIPTION
<b>CLIMATE CHANGE</b> (kg CO <sub>2</sub> eq)	It is related to the impact of emissions, called greenhouse gas emissions, on the radiative forcing of the atmosphere.
<b>OZONE DEPLETION</b> (kg CFC-11 eq)	Represents the impact on the Earth's atmosphere, reducing the ozone concentration in the stratosphere
<b>PARTICULATE MATTER</b> (incidence of diseases)	Covers the effects of primary fine particles and secondary, for which it has already been demonstrated correlation with respiratory diseases
<b>PHOTOCHEMICAL OZONE FORMATION</b> (kg NMVOC eq)	Photochemical ozone formation is the creation of reactive substances that affect human health and ecosystems
<b>ACIDIFICATION</b> (mol H <sup>+</sup> eq)	Acidification affects aquatic and terrestrial ecosystems by altering the acid-base balance
<b>EUTROPHIZATION (FRESHWATER)</b> (kg P eq)	Eutrophication includes impacts due to levels excessive macronutrients in ecosystems

# Life Impact Assessment

The method is based on the recommendation proposed by the European Commission within the context of the Environmental Footprint (EF) initiative. 12 impact categories were considered:

CATEGORY	DESCRIPTION
<b>HUMAN TOXICITY</b> (CTUh)	Includes impacts of emissions to air, water and soil that threaten human health.
<b>ECOTOXICITY</b> (CTUe)	Includes impacts generated by emissions into air, water and soil that threaten the health of the species.
<b>DEPLETION OF MINERAL RESOURCES</b> (kg Sb eq)	Shortage of mineral resources
<b>FOSSIL FUEL DEPLETION</b> (MJ)	Reflects the consumption of fossil fuels
<b>LAND OCCUPATION</b> (m <sup>2</sup> .a)	Reflects the reduction in area available for other crops.
<b>WATER USE</b> (m <sup>3</sup> )	Reflects water consumption.

# Categories that most concern society



### Mudanças Climáticas

Alteração do clima global, aumento de temperaturas e gases do efeito estufa



### Acidificação

Emissões produzidas que contribuem para a Chuva Ácida, Formação de Smog = Smoke and Fog



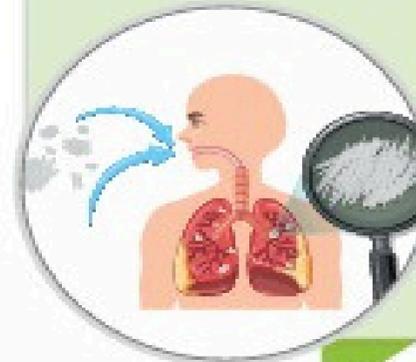
### Ocupação do Solo

Áreas ocupadas para exploração de atividades econômicas



### Material Particulado

Partículas finas que causam doenças respiratórias



### Ecotoxicidade

Emissões para o ar, água e solo que ameaçam a saúde de espécies



### Consumo de água

quantidade total de recursos hídricos utilizado no processo de produção

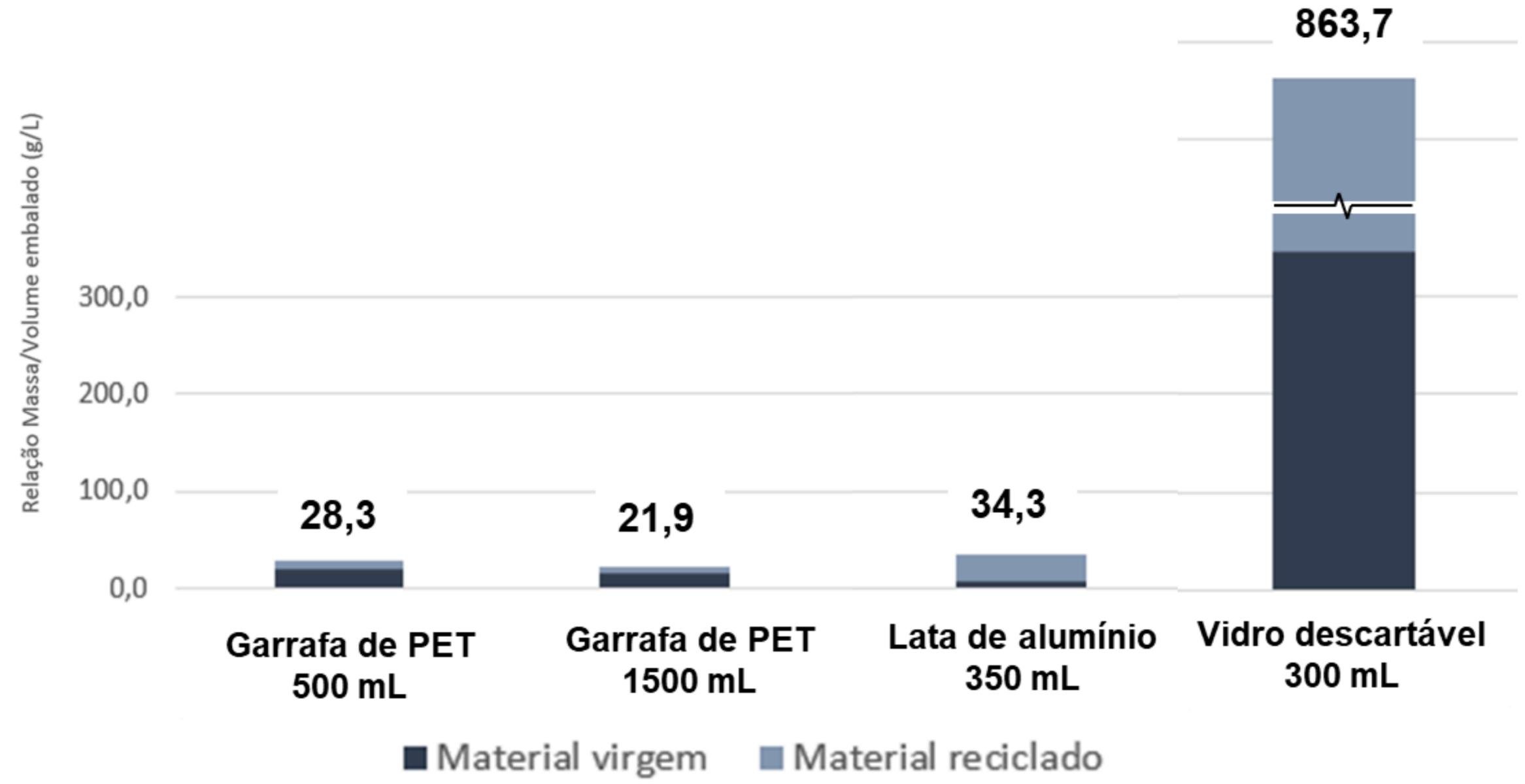


# RESULT: WATER



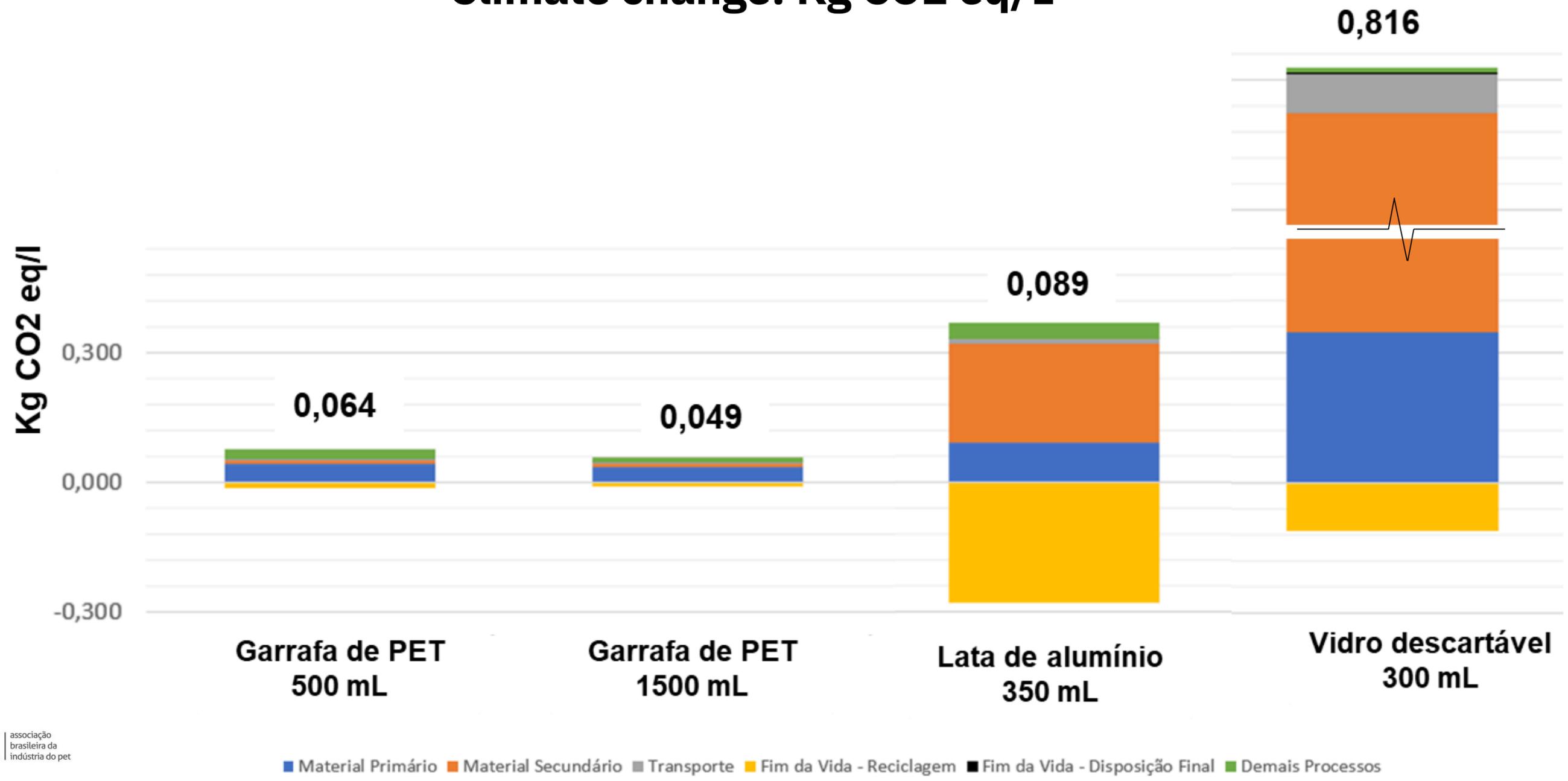
# Results: water

## Mass/Volume Ratio: g/L

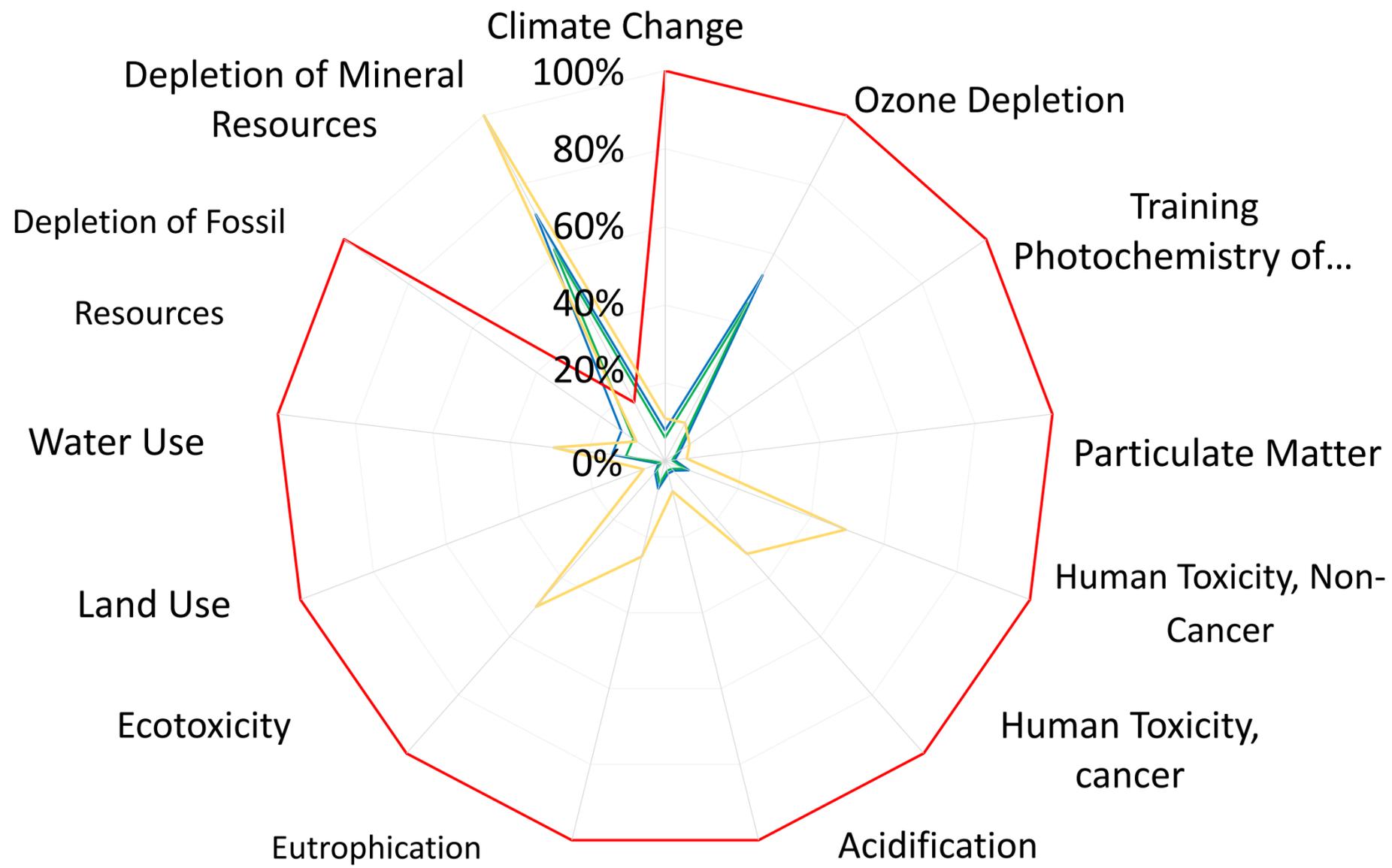


# Results: water

## Climate change: Kg CO2 eq/L



# Results: water



□ PET Bottle - WATER (500mL)  
□ Glass - disposable - WATER (300mL)

□ PET Bottle - WATER (1500mL)  
□ Aluminum Can (350mL)

# Results: water

The 500ml PET packaging:

- Use less **53% water** during production in relation to ALUMINUM packaging and contains 86% less water than GLASS packaging.
- It has a **94% lower** potential for generating particulate matter that causes respiratory diseases, compared to GLASS.

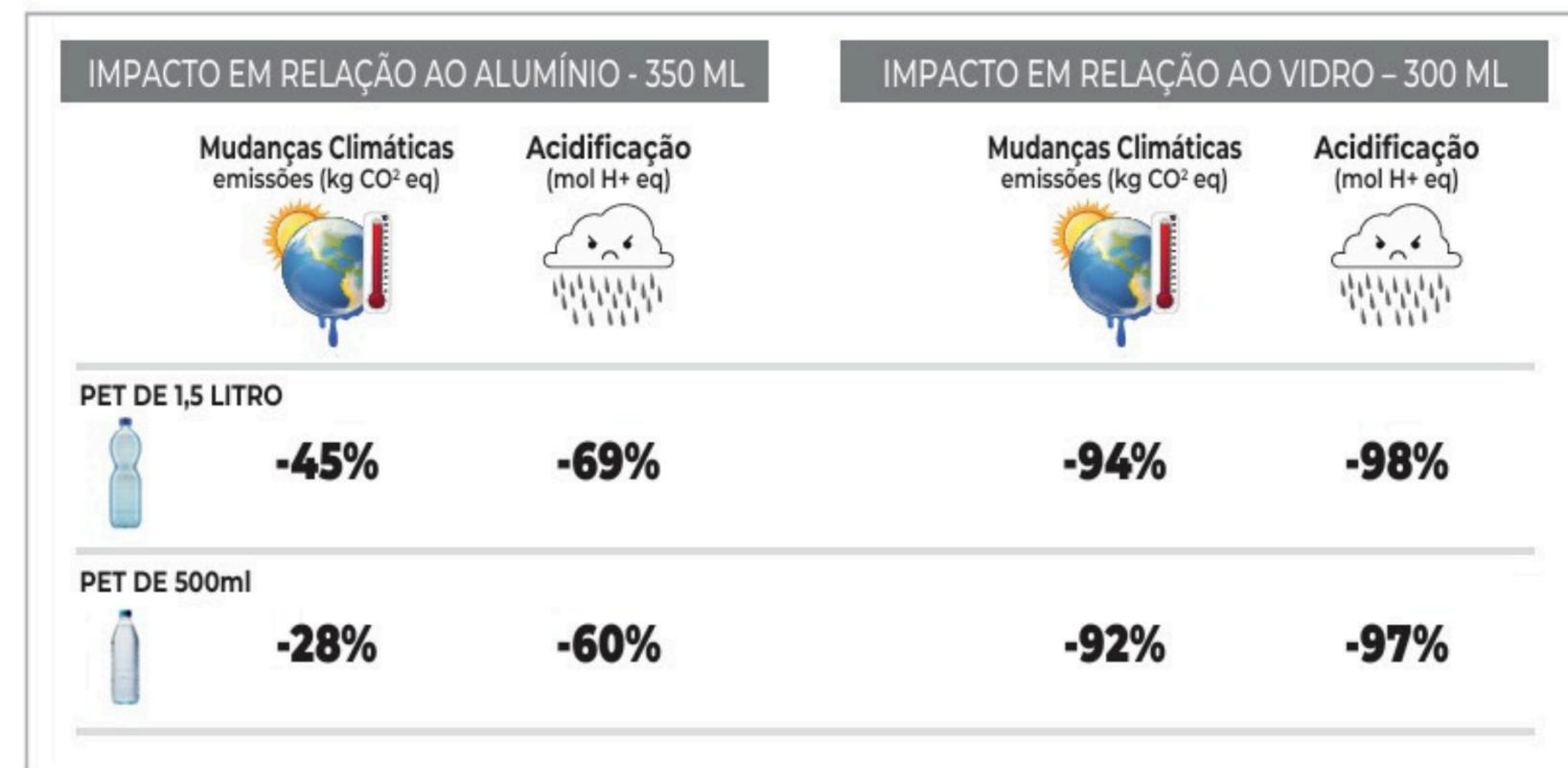
**If we talk about a 1.5 liter PET bottle:**

- The ecotoxicity index is **94% inferior**, in relation to the ALUMINUM and **97% smaller** in relation to GLASS.
- In the case of land use, the index is 99% to the inferior GLASS.

Quanto o PET é menos impactante que:

ALUMÍNIO

VIDRO



# Results: soda

## The 2-liter PET packaging:

- Uses **64% less water** during production, compared to **ALUMINUM** packaging and **88% less water** than **GLASS** packaging.
- Has a **44% lower climate change potential** compared to **ALUMINUM** packaging and **93% in relation to GLASS** packaging.

## Quanto o PET é menos impactante que:

### ALUMÍNIO

### VIDRO

	IMPACTO EM RELAÇÃO AO ALUMÍNIO - 350 ML		IMPACTO EM RELAÇÃO AO VIDRO - 250 ML	
	Material Particulado (disease inc.)	Ecotoxicidade (CTUe)	Material Particulado (disease inc.)	Ecotoxicidade (CTUe)
PET DE 2 LITROS				
	<b>-97%</b>	<b>-93%</b>	<b>-98%</b>	<b>-96%</b>
PET DE 600ml		<b>-92%</b>	<b>-85%</b>	<b>-91%</b>

THANKS  
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