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# Comparative Life Cycle Assessment of Tetra Recart<sup>®</sup> packages and alternative packaging systems for shelf stable pet and baby food on the European, US and Japanese markets






Extended summary, May 2021

Samuel Schlecht & Frank Wellenreuther

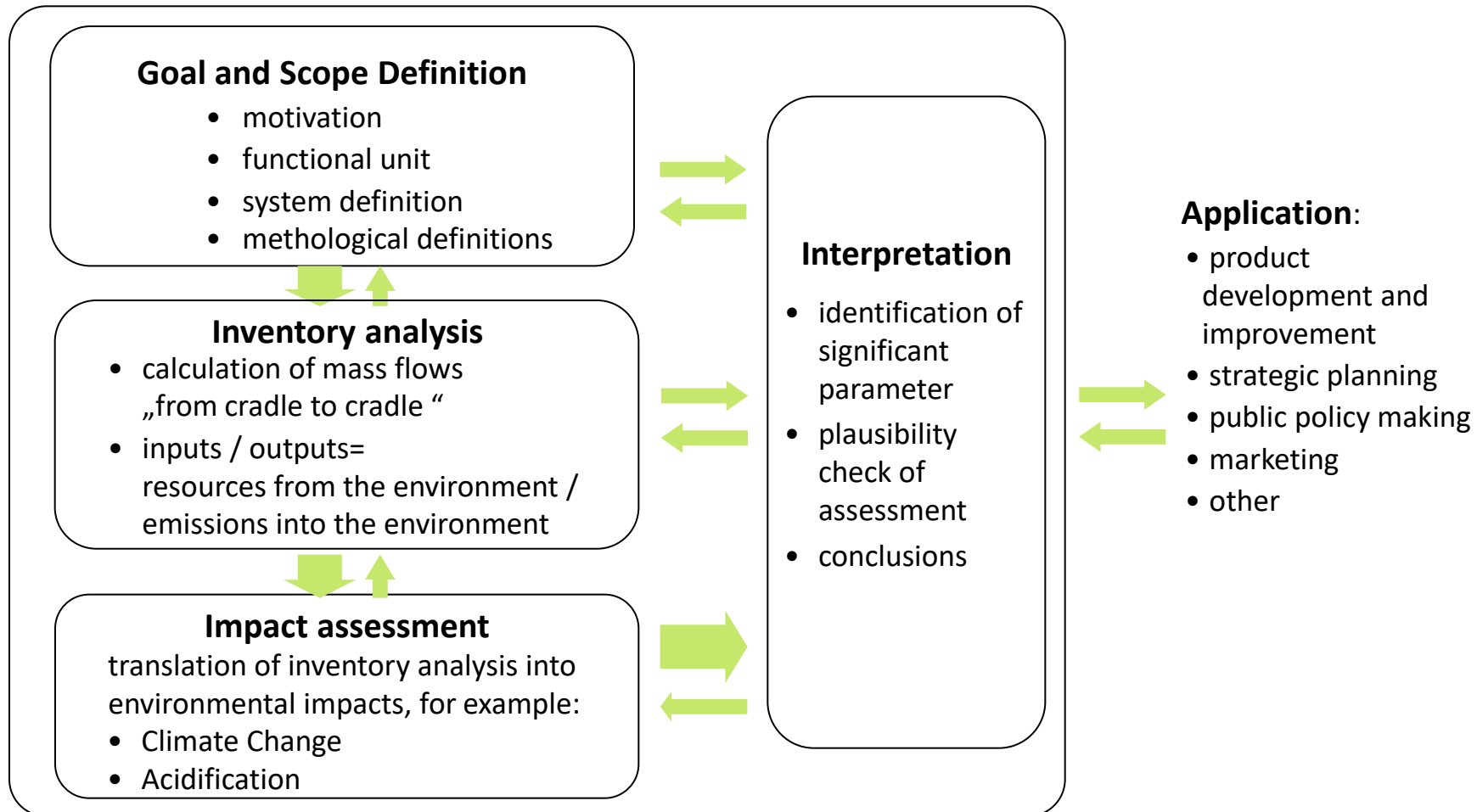


# Content

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-  Life Cycle Assessment
-  Goal and scope
-  Packaging systems and scenarios
-  Results
-  Overall results

# Structure as in (ISO 14040/14044)



# Objective



The goal of the study is to conduct an LCA analysing the environmental performance of Tetra Pak’s Tetra Recart® carton systems compared to alternative food packaging systems for the segments pet food and baby food.

Competing packaging systems on the regarded markets Europe, USA and Japan include:

	Aluminium can	Steel can	Glass jar	Pouch	Rigid plastic	Aluminium tray
Europe		Pet food		Pet food		Pet food
			Baby food	Baby food	Baby food	
USA	Pet food				Pet food	
			Baby food	Baby food	Baby food	
Japan				Baby food	Baby food	

# Functional unit and time scope

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## Functional unit

The function examined in this LCA study is the packaging of shelf stable food for retail. The functional unit for this study is the provision of packaging volume for 1000 kg of shelf stable food at the point of sale.

## Time scope

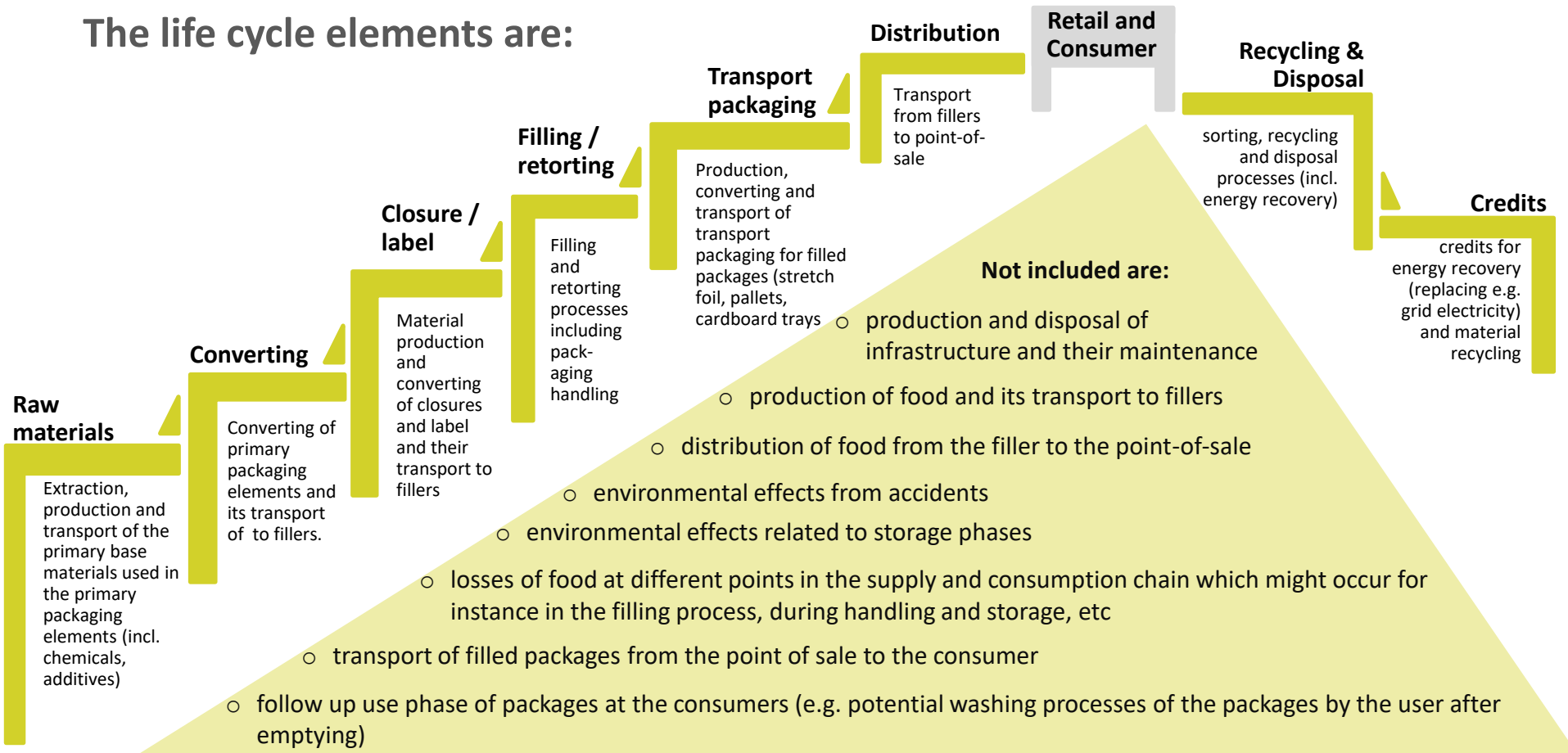
The reference time period for the comparison of packaging systems is 2020. Where no figures are available for these years, the used data is as up-to-date as possible.

# System boundaries



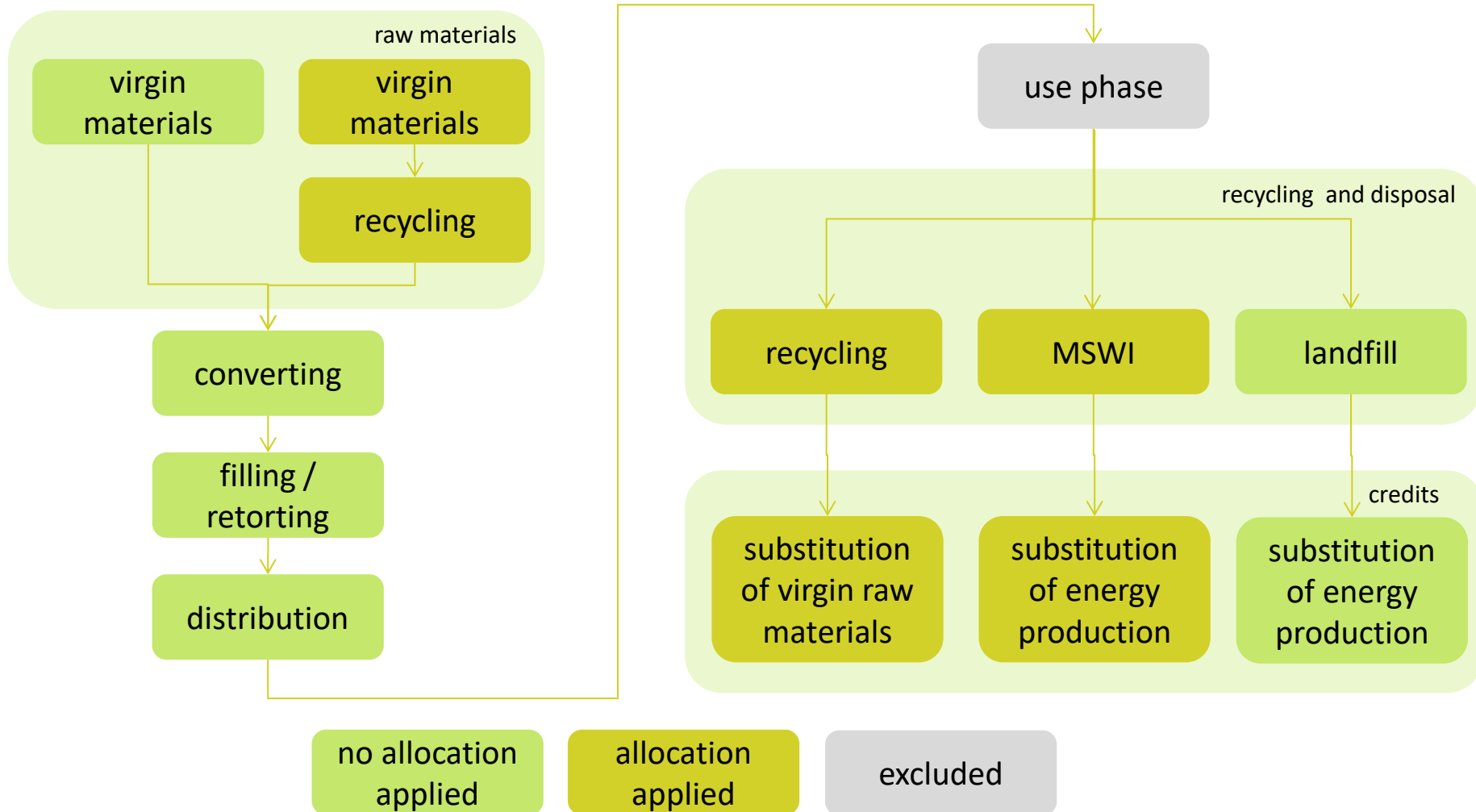
The study is designed as a 'cradle-to-grave' LCA.

The life cycle elements are:



# Allocation

processes allocation is applied to

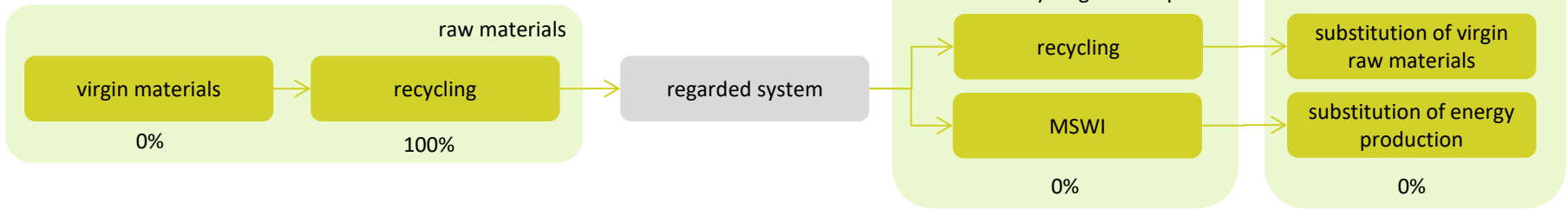


# Allocation

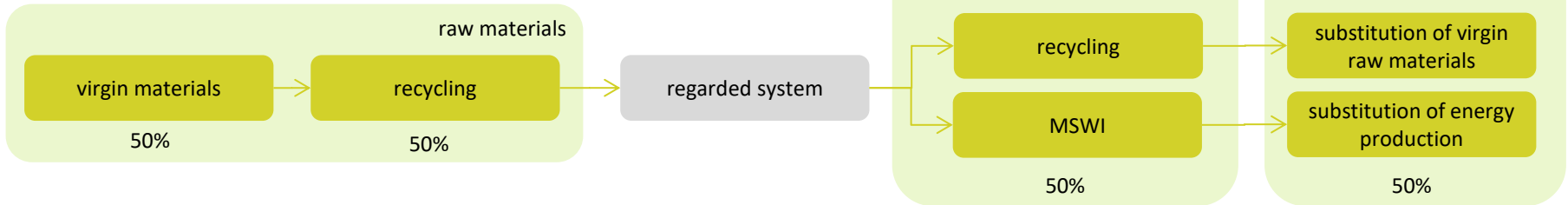
allocation factors for processes for which allocation is applied to



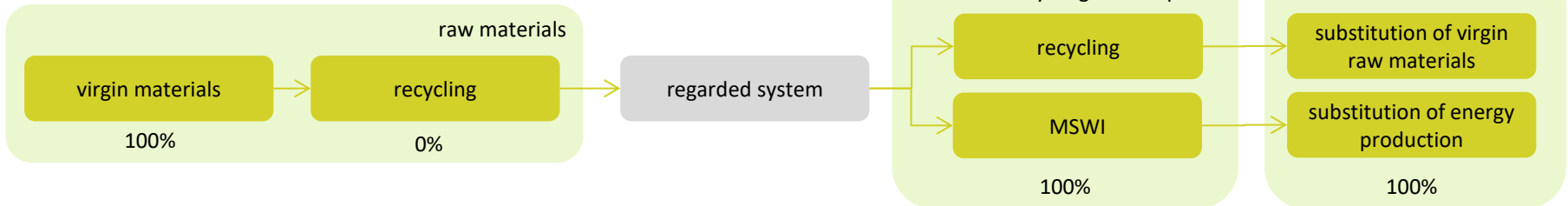
allocation factor 0%:  
rewards usage of recycled material



allocation factor 50%:  
rewards usage of recycled material and efficient recycling and recovery



allocation factor 100%:  
rewards efficient recycling and recovery



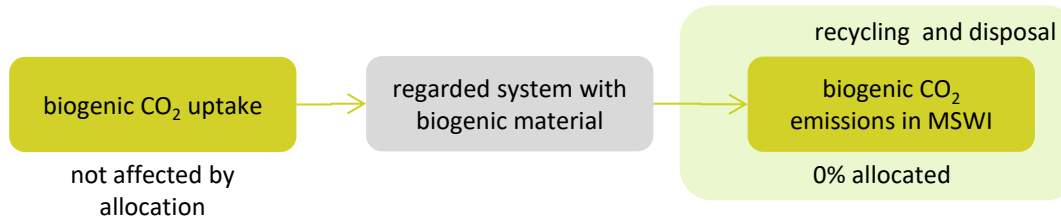


# Allocation

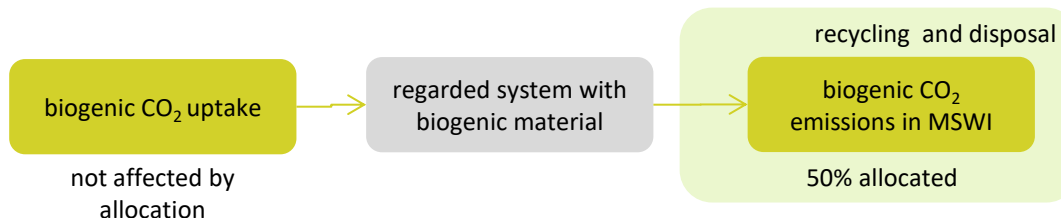
## effects on biogenic CO<sub>2</sub>



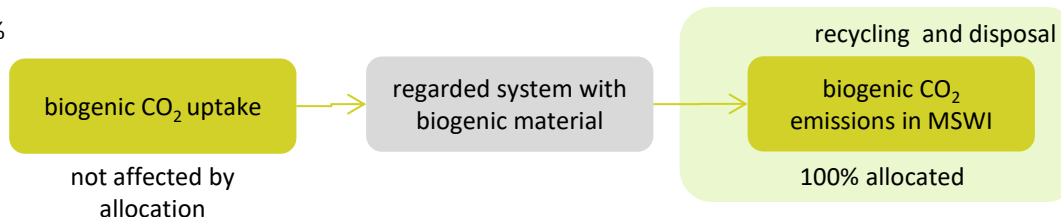
allocation 0%



allocation 50%



allocation 100%



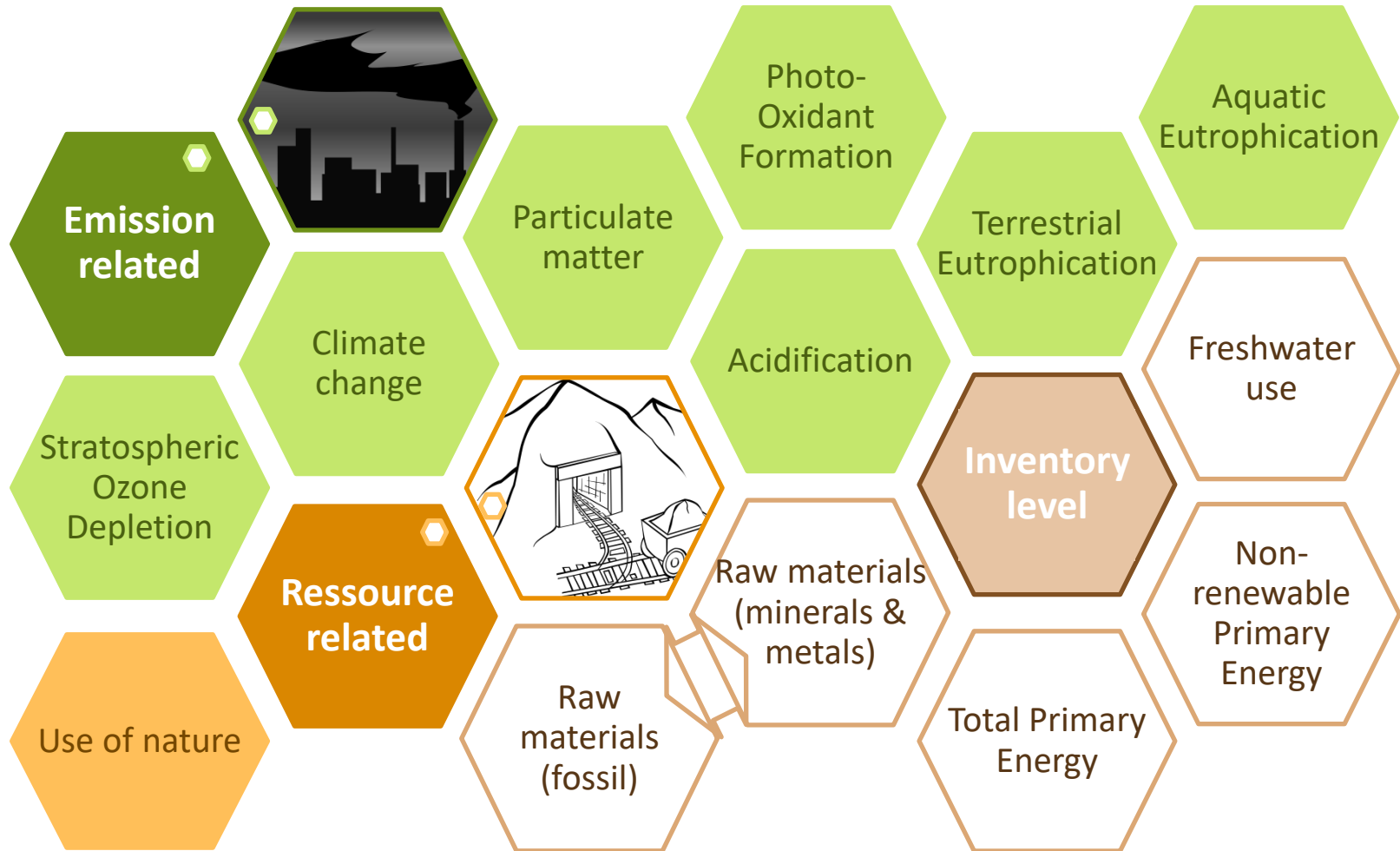
# Time and geographic scope

## Geographic scope

- The LCA study focuses on the production, distribution and disposal of packaging systems on the European, the US and the Japanese market.
- Regarding alternative packaging systems all life cycle steps are set in the respective market.
- For a certain share of the raw materials, country-specific data is used as well as European averages depending on the availability.
- Locations of life cycle steps regarding Tetra Recart® packaging systems are shown in the following table:

	Europe	United States (base)	United States (variant)	Japan
materials				
LPB	Sweden	Sweden	Sweden	Sweden
plastics	Europe	Europe	US	Europe
aluminium	Europe	Europe	Europe	Europe
converting	Hungary	Hungary	US	Hungary
filling/retorting	Europe	US	US	Japan
end of life	Europe	US	US	Japan

# Environmental categories of the LCA study



# Selection of packaging systems

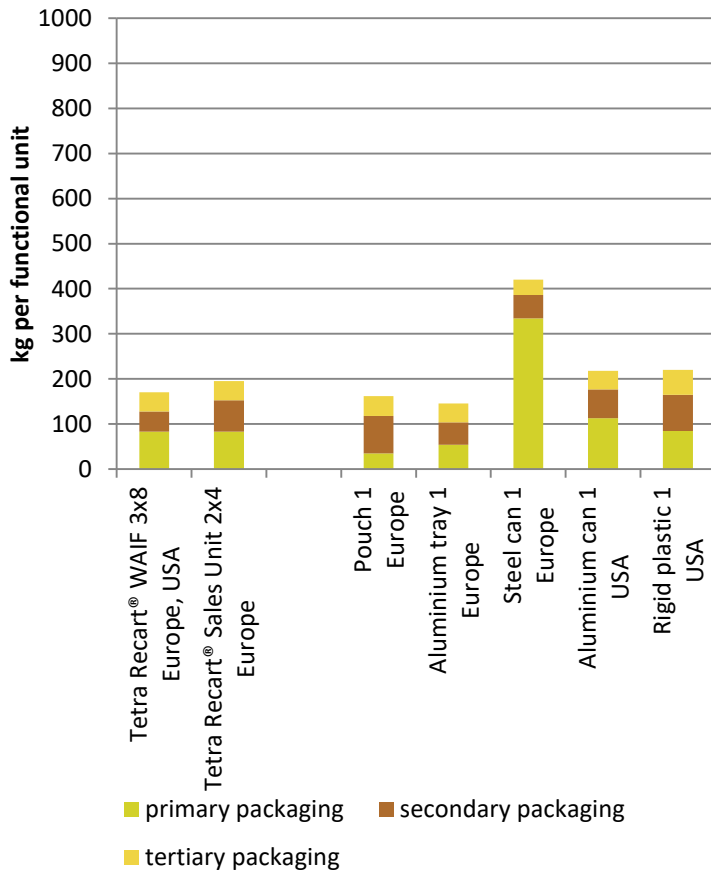


Pet food		
Carton based packaging systems	Geographic scope	Competing packaging systems
<b>Tetra Recart®</b> <b>Wrap Around Inside Flaps (WAIF) 3x8</b> <b>100 g</b> 	Europe	Pouch 1 100 g 
		Aluminium tray 1 100 g 
		Steel can 1 100 g 
<b>Tetra Recart®</b> <b>Sales Unit 2x4</b> <b>100 g</b> 	Europe	Pouch 1 100 g 
		Aluminium tray 1 100 g 
		Steel can 1 100 g 
<b>Tetra Recart®</b> <b>Wrap Around Inside Flaps (WAIF) 3x8</b> <b>100 g</b> 	United States	Aluminium can 1 85 g 
		Rigid plastic 1 78 g 

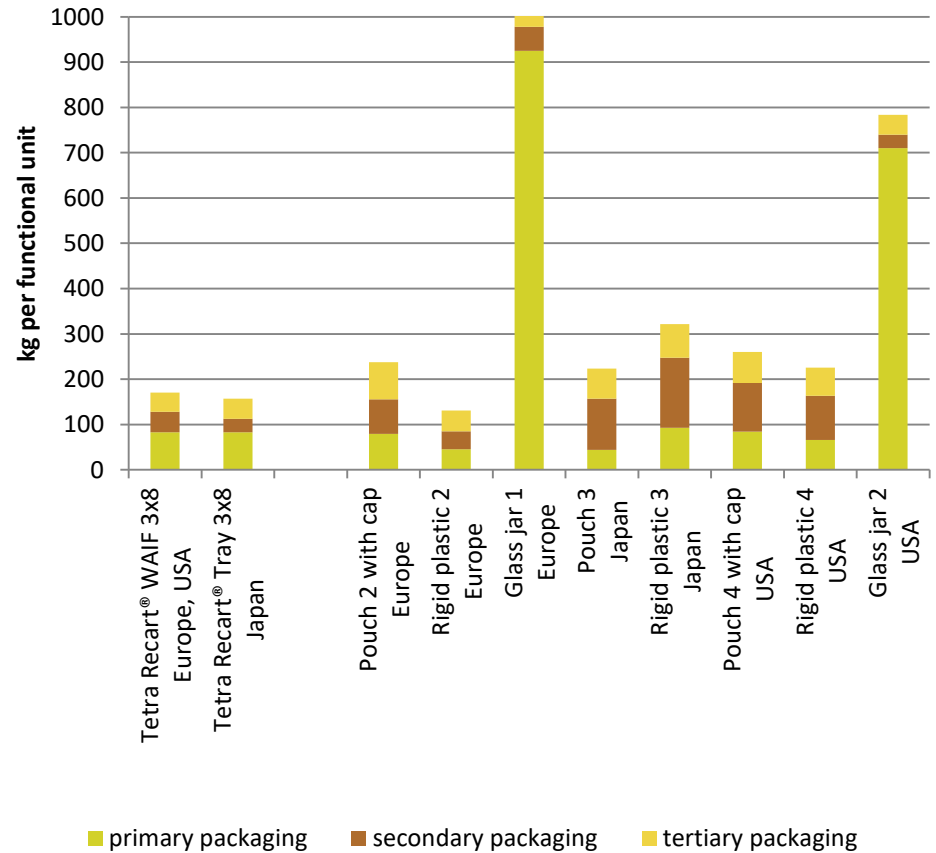
Baby food		
Carton based packaging systems	Geographic scope	Competing packaging systems
<b>Tetra Recart®</b> <b>Wrap Around Inside Flaps (WAIF) 3x8</b> <b>100 g</b> 	Europe	Pouch 2 with cap 100 g 
		Rigid plastic 2 100 g 
		Glass jar 1 100 g 
<b>Tetra Recart®</b> <b>Tray 3x8</b> <b>100 g</b> 	Japan	Pouch 3 100 g 
		Rigid plastic 3 90 g 
<b>Tetra Recart®</b> <b>Wrap Around Inside Flaps (WAIF) 3x8</b> <b>100 g</b> 	United States	Pouch 4 with cap 99 g 
		Rigid plastic 4 114 g 
		Glass jar 2 113 g 

# Packaging weights

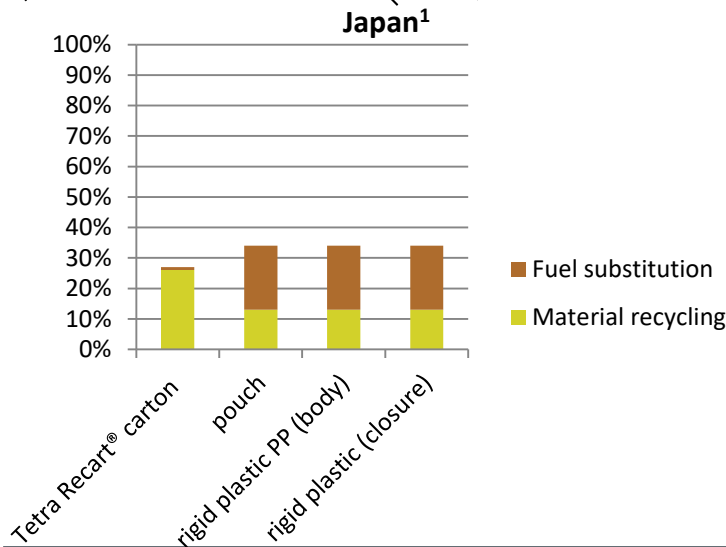
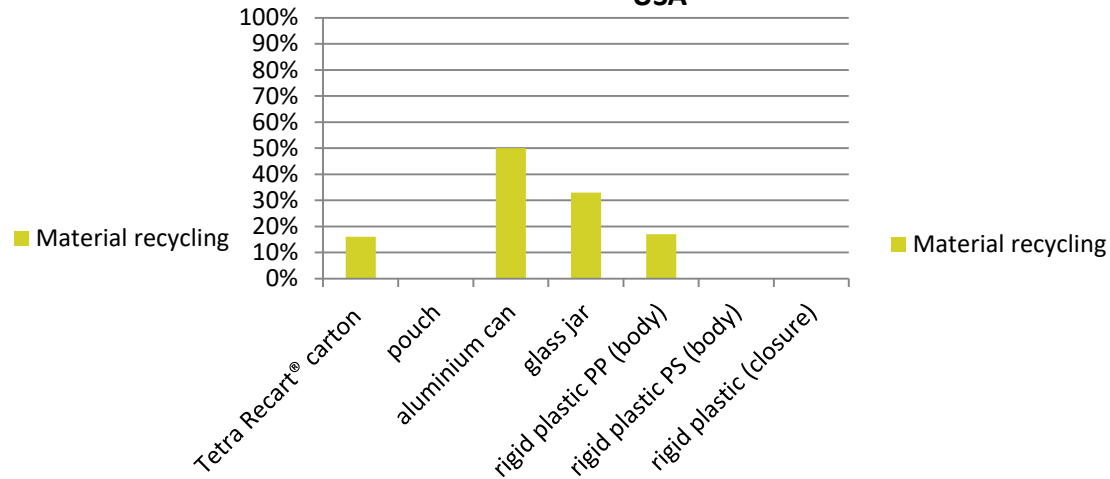
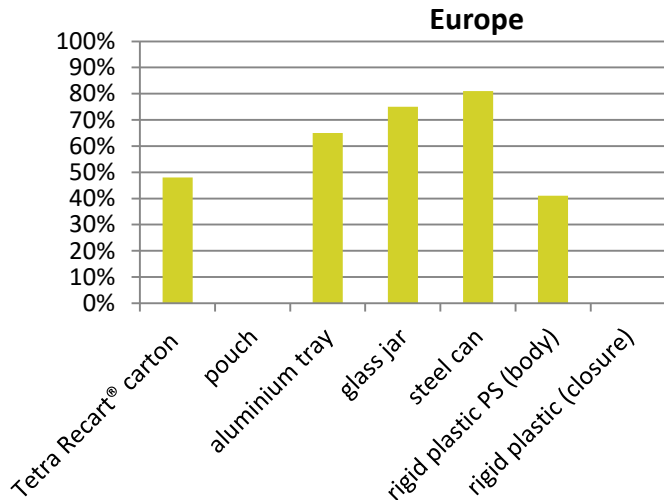
## pet food



## baby food



# End of life recycling rates



- High recycling rates are more beneficial for plastic, glass and metal packaging systems than carton based packaging systems as their substitution of virgin materials leads to higher material credits than the substitution of fibres from carton based packaging systems.

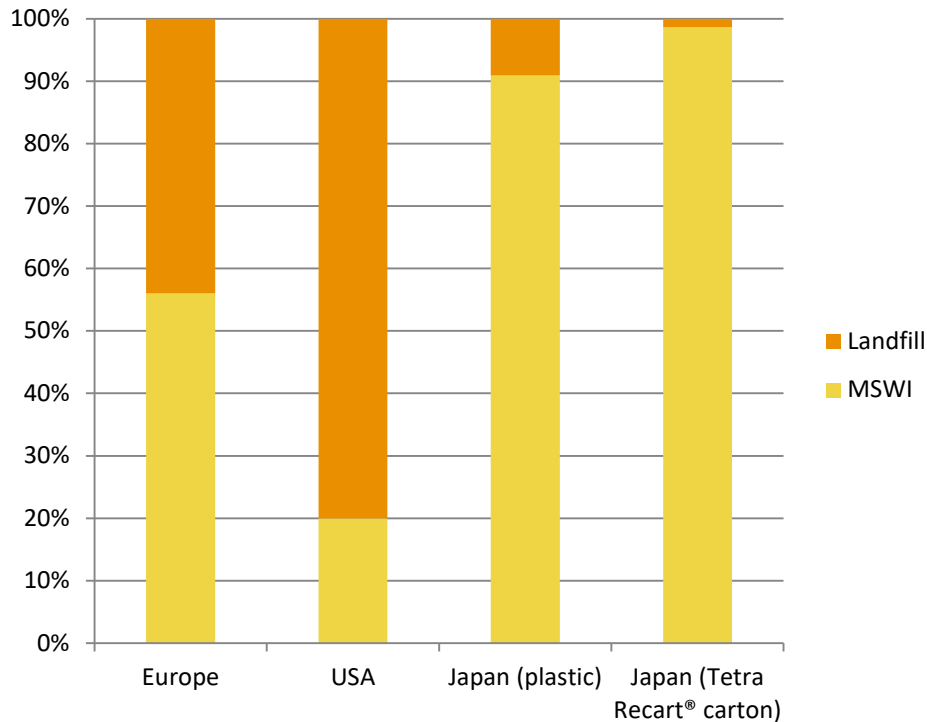
● 14 <sup>1</sup>In this report, the waste plastic treatment in coke ovens and blast furnaces as coal substitution, which is referred to as “chemical recycling” in Japan, is categorized as fuel substitution.

# End of life

## final treatment



Final treatment split



- The final treatment split refers to non-recycled waste flows and the final treatment after the recycled life cycle.
- High shares of landfill leads to high Climate Change impacts for Tetra Recart<sup>®</sup> packaging systems due to methane emissions resulting from the degradation of paper on landfills.

# Scenarios

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## Base scenarios

For each of the studied packaging systems a scenario on the European, US and Japanese market is defined, which is intended to reflect the most realistic situation under the described scope. These scenarios are clustered into groups within the same segment and volume group. Following the ISO standard's recommendation, a variation of the allocation procedure is conducted. Therefore, three scenarios regarding the open-loop allocation are calculated for each packaging system:

- with a system allocation factor of 50 %
- with a system allocation factor of 100 %
- with a system allocation factor of 0 %



# Scenarios

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## Scenario Variants

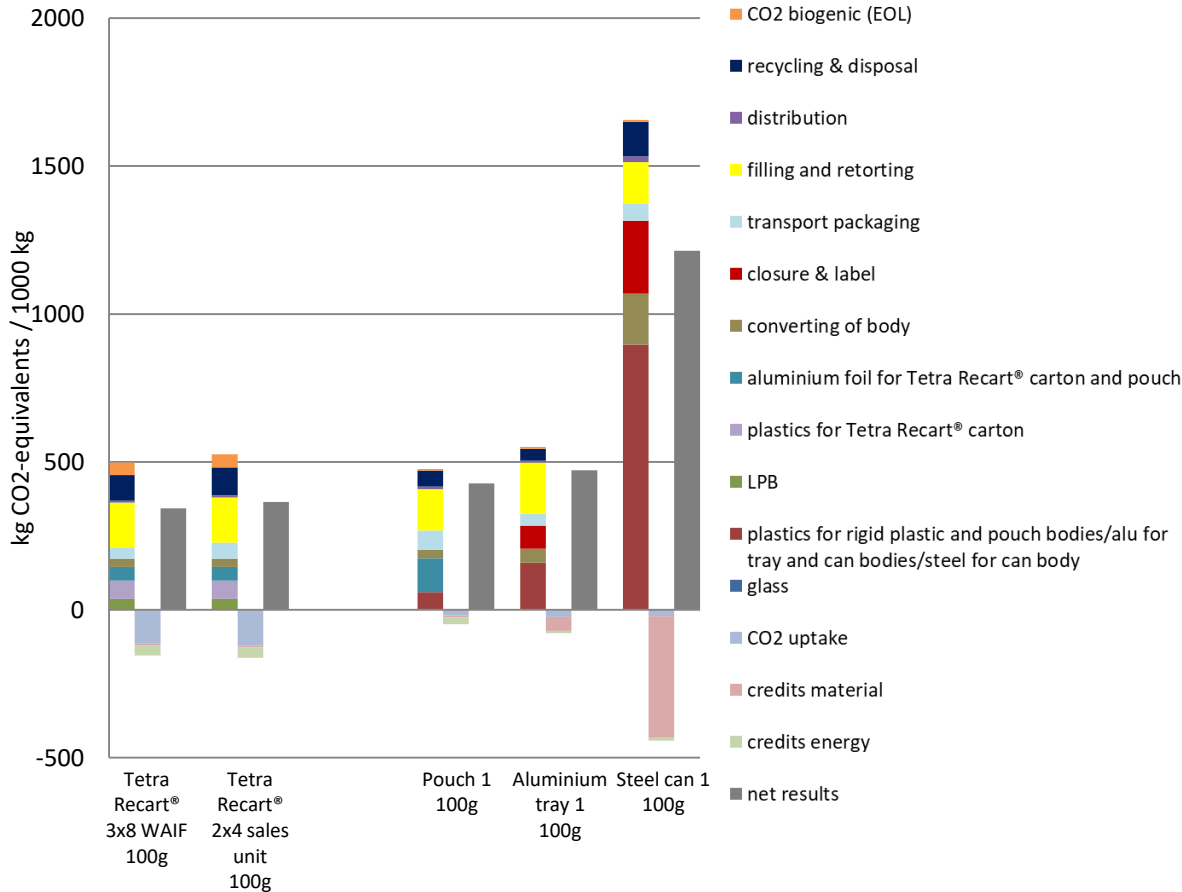
- Scenario variants regarding recycling rate up to 90%
  - flexible multilayer films excluded (pouches and lids of rigid plastic)
- Scenario variants regarding recycled content in competing packaging system for the materials
  - main plastics (PET, PE; PP)
  - aluminium (aluminium foil in Tetra Recart<sup>®</sup> and pouches excluded)
  - Steel
- Scenario variant regarding Tetra Recart's<sup>®</sup> production locations for the US market

# Pet food Europe

## contribution analysis allocation 50% - Climate Change



### Climate Change



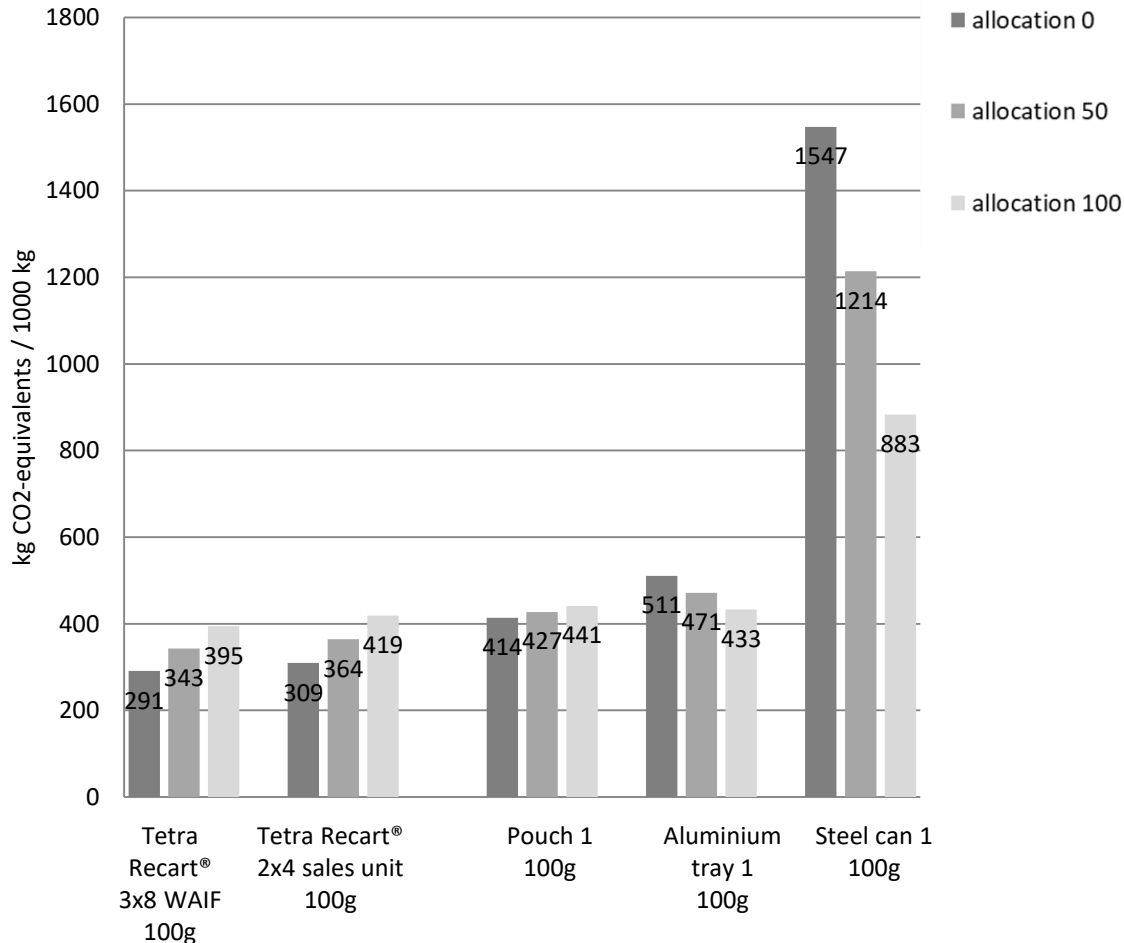
- The following life cycle steps have a share of total Climate Change burdens higher than 20%:
  - Tetra Recart®:
    - filling and retorting: 29%-31%
    - raw materials body (LPB, plastics, aluminium foil): 27%-29%
    - recycling & disposal + CO2 biogenic (EOL): 26%
  - Pouch 1 / Aluminium Tray 1:
    - filling and retorting: 29%-31%
    - raw materials body (plastics, aluminium foil): 29%-37%
  - Steel can 1:
    - raw materials body (steel): 54%

# Pet food Europe

allocation 0%, 50%, 100% - Climate Change



## Climate Change



- Regarding Climate Change, with higher allocation factors, net results
  - increase for Tetra Recart® due to the higher allocation of biogenic CO<sub>2</sub> emissions.
  - stay about the same for Pouch 1 as burdens from incineration and resulting energy credits are similar
  - decrease for aluminium tray 1 and Steel can 1 as material credits are higher than burdens from material recycling.

# Pet food, Europe comparative results



Pet food, Europe, Allocation 0	The net results of <b>Tetra Recart® 3x8 WAIF 100g</b> are lower (green) higher (orange) than those of			
	Tetra Recart® 2x4 sales unit 100g	Pouch 1 100g	Aluminium tray 1 100g	Steel can 1 100g
Climate Change	-6%	-30%	-43%	-81%
Acidification	-5%	-3%	-34%	-69%
Photo-Oxidant Fomation	-5%	+5%	-17%	-67%
Ozone Depletion Potential	-3%	+69%	+154%	+20%
Terrestrial Eutrophication	-6%	+12%	-13%	-63%
Aquatic Eutrophication	-7%	+57%	+276%	+43%
Particulate Matter	-5%	-0%	-30%	-69%
Use of Nature	-7%	+311%	+462%	+375%

Pet food, Europe, Allocation 50	The net results of <b>Tetra Recart® 3x8 WAIF 100g</b> are lower (green) higher (orange) than those of			
	Tetra Recart® 2x4 sales unit 100g	Pouch 1 100g	Aluminium tray 1 100g	Steel can 1 100g
Climate Change	-6%	-20%	-27%	-72%
Acidification	-5%	-5%	-30%	-65%
Photo-Oxidant Fomation	-6%	+4%	-12%	-61%
Ozone Depletion Potential	-3%	+72%	+164%	+26%
Terrestrial Eutrophication	-6%	+11%	-7%	-56%
Aquatic Eutrophication	-7%	+51%	+265%	+28%
Particulate Matter	-5%	-2%	-25%	-63%
Use of Nature	-8%	+259%	+395%	+351%

Pet food, Europe, Allocation 100	The net results of <b>Tetra Recart® 3x8 WAIF 100g</b> are lower (green) higher (orange) than those of			
	Tetra Recart® 2x4 sales unit 100g	Pouch 1 100g	Aluminium tray 1 100g	Steel can 1 100g
Climate Change	-6%	-10%	-9%	-55%
Acidification	-5%	-8%	-23%	-57%
Photo-Oxidant Fomation	-6%	+3%	-6%	-51%
Ozone Depletion Potential	-3%	+75%	+175%	+34%
Terrestrial Eutrophication	-6%	+11%	-0%	-44%
Aquatic Eutrophication	-8%	+44%	+254%	+14%
Particulate Matter	-6%	-4%	-19%	-54%
Use of Nature	-9%	+207%	+327%	+322%

- Main conclusions considering results with all allocation factors:
  - **Tetra Recart® 3x8 WAIF** shows lower impacts for ‘Climate Change’ than Pouch 1 and Steel can 1.
  - **Tetra Recart® 3x8 WAIF** shows lower impacts for ‘Acidification’, Photo-Oxidant Formation’, Terrestrial Eutrophication’ and ‘Particulate Matter’ than Steel can 1.
  - **Tetra Recart® 3x8 WAIF** shows lower impacts for ‘Acidification’ and ‘Particulate Matter’ than Aluminium tray 1.
  - **Tetra Recart® 3x8 WAIF** shows higher impacts for ‘Ozone Depletion Potential’, ‘Aquatic Eutrophication’ and ‘Use of Nature’ than all regarded competing packaging systems.

● 20		Tetra Recart® better than alternative packaging system
		Tetra Recart® similar as alternative packaging system
		Tetra Recart® worse than alternative packaging system

# Pet food, Europe comparative results



Pet food, Europe, Allocation 0	The net results of Tetra Recart® 2x4 sales unit 100g are lower (green) higher (orange) than those of			
	Tetra Recart® 3x8 WAIF 100g	Pouch 1 100g	Aluminium tray 1 100g	Steel can 1 100g
Climate Change	+6%	-25%	-39%	-80%
Acidification	+5%	+2%	-31%	-68%
Photo-Oxidant Formation	+6%	+10%	-13%	-65%
Ozone Depletion Potential	+3%	+74%	+162%	+24%
Terrestrial Eutrophication	+6%	+19%	-8%	-61%
Aquatic Eutrophication	+7%	+69%	+303%	+54%
Particulate Matter	+5%	+5%	-26%	-67%
Use of Nature	+7%	+341%	+503%	+409%

Pet food, Europe, Allocation 50	The net results of Tetra Recart® 2x4 sales unit 100g are lower (green) higher (orange) than those of			
	Tetra Recart® 3x8 WAIF 100g	Pouch 1 100g	Aluminium tray 1 100g	Steel can 1 100g
Climate Change	+6%	-15%	-23%	-70%
Acidification	+5%	+0%	-26%	-63%
Photo-Oxidant Formation	+6%	+10%	-7%	-58%
Ozone Depletion Potential	+3%	+77%	+172%	+30%
Terrestrial Eutrophication	+6%	+18%	-2%	-53%
Aquatic Eutrophication	+8%	+63%	+294%	+38%
Particulate Matter	+6%	+4%	-21%	-61%
Use of Nature	+8%	+289%	+437%	+388%

Pet food, Europe, Allocation 100	The net results of Tetra Recart® 2x4 sales unit 100g are lower (green) higher (orange) than those of			
	Tetra Recart® 3x8 WAIF 100g	Pouch 1 100g	Aluminium tray 1 100g	Steel can 1 100g
Climate Change	+6%	-5%	-3%	-53%
Acidification	+6%	-2%	-19%	-55%
Photo-Oxidant Formation	+6%	+9%	-0%	-48%
Ozone Depletion Potential	+3%	+80%	+183%	+38%
Terrestrial Eutrophication	+7%	+18%	+6%	-40%
Aquatic Eutrophication	+8%	+56%	+284%	+23%
Particulate Matter	+6%	+2%	-14%	-51%
Use of Nature	+10%	+237%	+369%	+364%

- Main conclusions considering results with both allocation factors:
  - Tetra Recart® 2x4 sales unit shows lower impacts for ‘Climate Change’, ‘Acidification’, ‘Photo-Oxidant Formation’, ‘Terrestrial Eutrophication’ and ‘Particulate Matter’ than Steel can 1.
  - Tetra Recart® 2x4 sales unit shows lower impacts for ‘Acidification’ and ‘Particulate Matter’ than Aluminium can 1.
  - Tetra Recart® 2x4 sales unit shows higher impacts for ‘Ozone Depletion Potential’, ‘Aquatic Eutrophication’ and ‘Use of Nature’ than all regarded competing packaging systems.

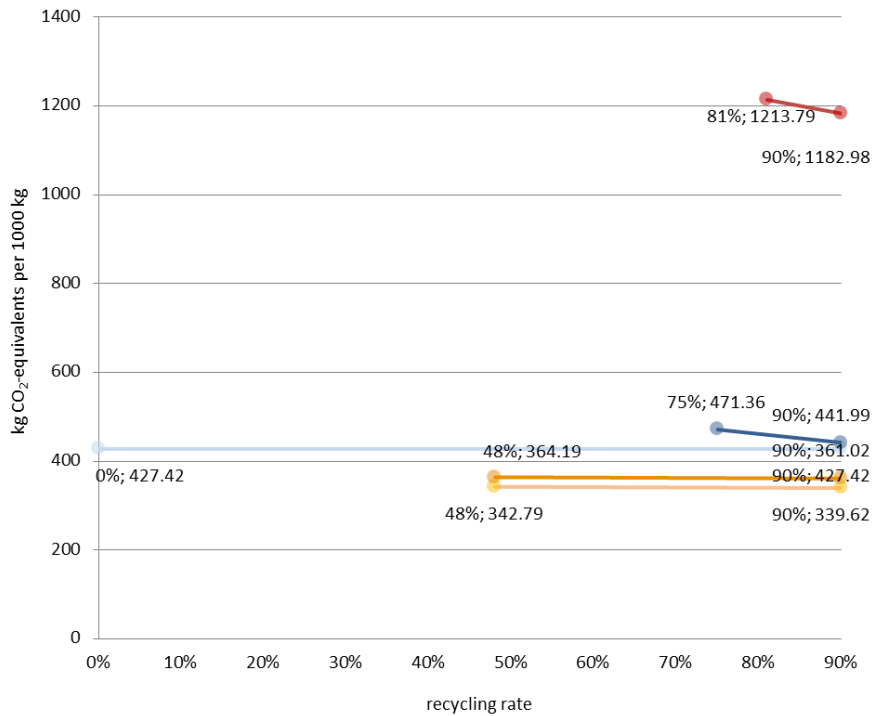
● 21		Tetra Recart® better than alternative packaging system
		Tetra Recart® similar as alternative packaging system
		Tetra Recart® worse than alternative packaging system

# Pet food Europe

## scenario variant – recycling rate



### Climate Change



- Scenario variants regarding recycling rate do not change the comparative conclusions in this segment.
- Exemplary graph for 'Climate Change'

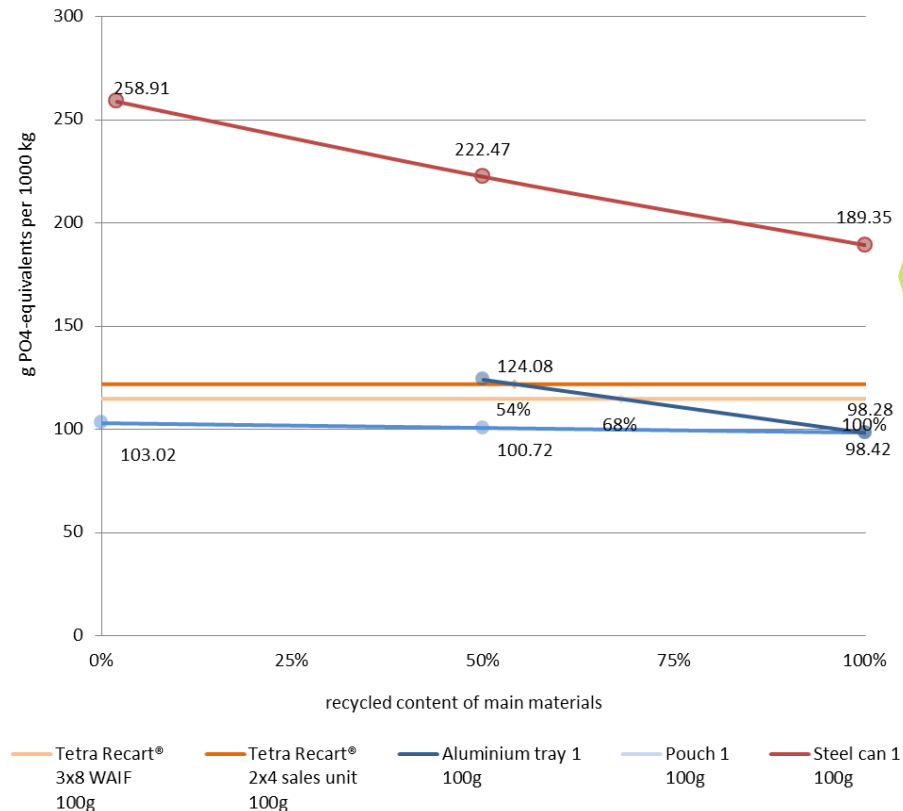
— Tetra Recart® 3x8 WAIF 100g    
 — Tetra Recart® 2x4 sales unit 100g    
 — Aluminium tray 100g    
 — Pouch 100g    
 — Steel can 100g

# Pet food Europe

## scenario variant - recycled content



### Terrestrial Eutrophication



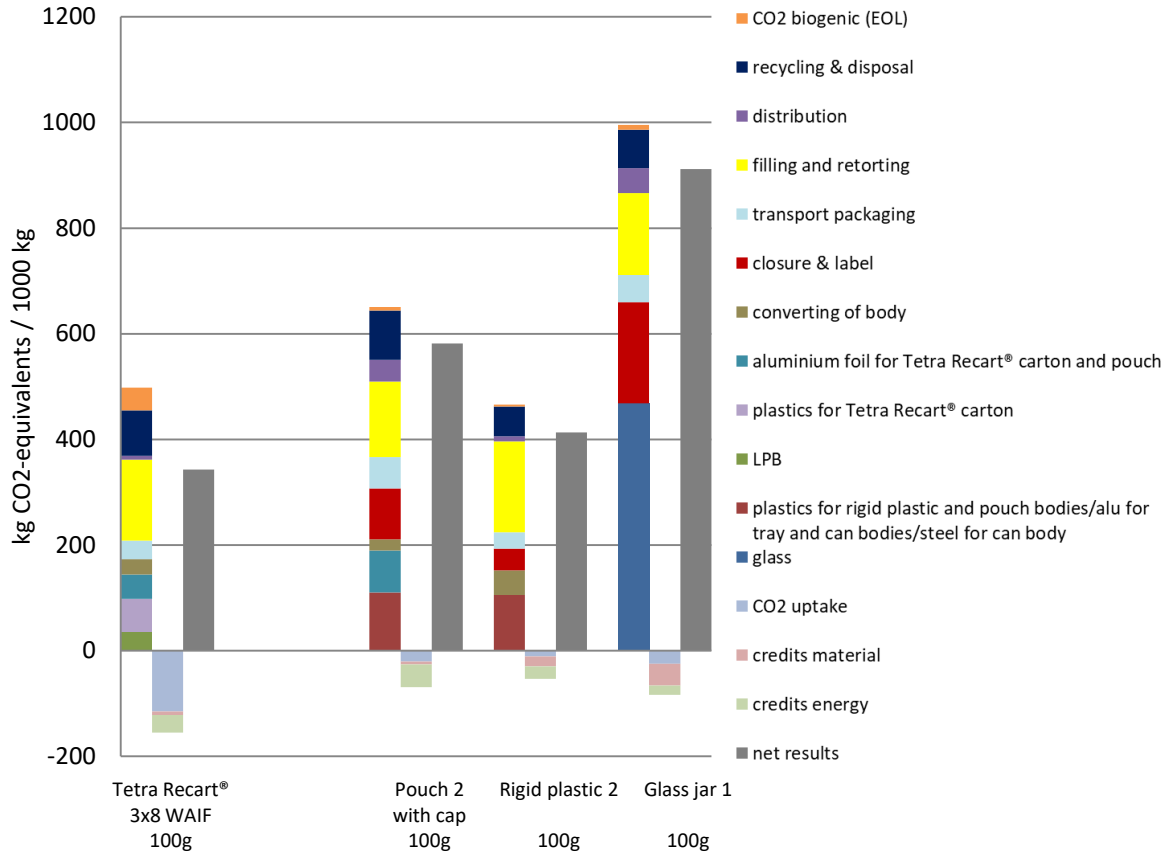
- Scenario variants regarding recycled content change the comparative conclusions in this segment in the following cases:
  - 'Terrestrial Eutrophication': Aluminium tray 1 breaks even with Tetra Recart® 2x4 sales unit with a share of recycled content in its main materials of 54%, leading to higher net results for the Tetra Recart® 2x4 sales. Aluminium tray 1 breaks even with Tetra Recart® 3x8 WAIF with a share of recycled content in its main materials of 68%, leading to higher net results for the Tetra Recart® 3x8 WAIF.
  - 'Acidification': Aluminium tray 1 breaks even with Tetra Recart® 2x4 sales unit with a share of recycled content in its main materials of 96% leading to similar net results in this comparison.
  - 'Photo-Oxidant Formation': Aluminium tray 1 breaks even with Tetra Recart® 2x4 sales unit with a share of recycled content in its main materials of 68% leading to higher net results for the Tetra Recart® 2x4 sales unit.

# Baby food, Europe

## contribution analysis allocation 50% - Climate Change



### Climate Change



- The following life cycle steps have a share of total Climate Change burdens higher than 20%:
  - Tetra Recart®:
    - filling and retorting: 31%
    - raw materials body (LPB, plastics, aluminium foil): 29%
    - recycling & disposal + CO2 biogenic (EOL): 26%
  - Pouch 2 with cap / Rigid plastic 2:
    - filling and retorting: 22%-37%
    - raw materials (plastics, aluminium foil): 23%-29%
  - Glass jar 1:
    - raw materials (glass): 47%

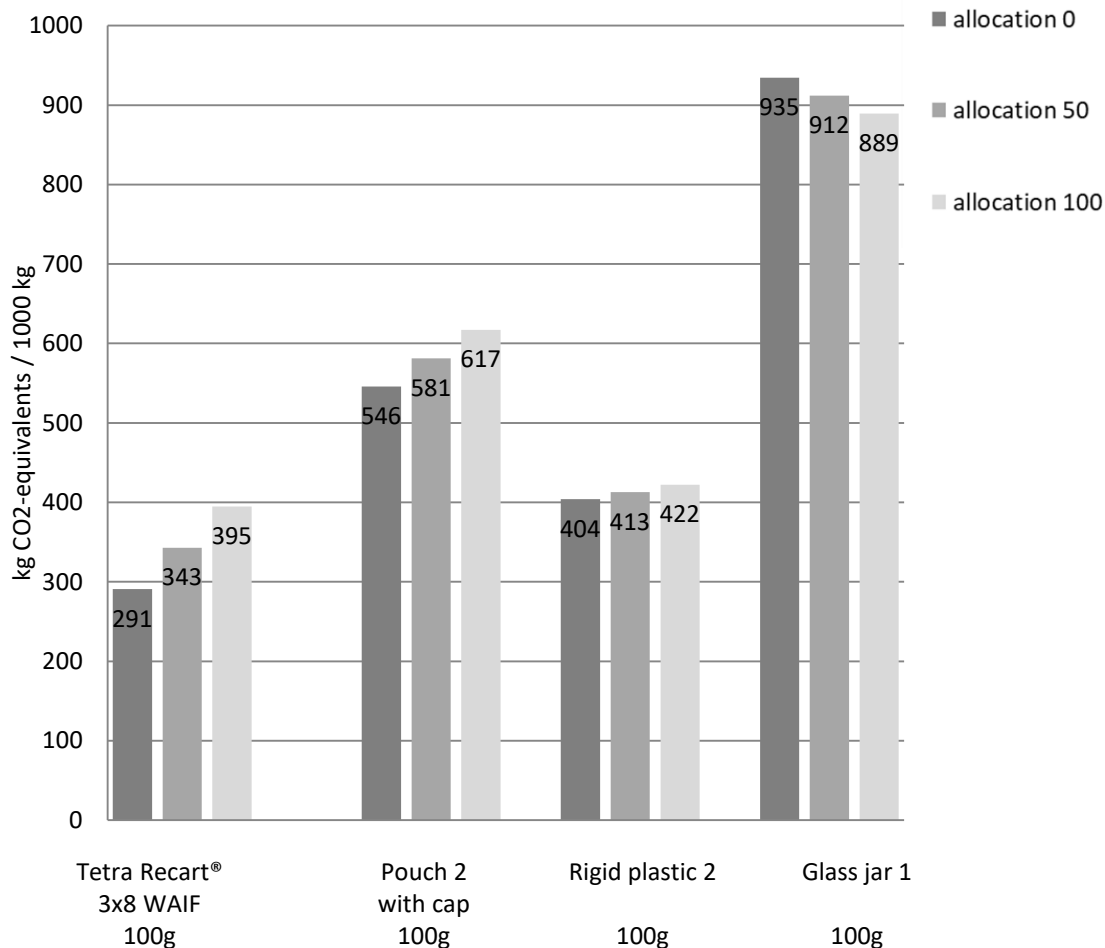


# Baby food Europe

## allocation 0%, 50%, 100% - Climate Change



### Climate Change



- Regarding Climate Change, with higher allocation factors, net results
  - increase for Tetra Recart® due to the higher allocation of biogenic CO<sub>2</sub> emissions.
  - increase for Pouch 2 with cap as burdens from incineration are higher than resulting energy credits due to the high share of plastic from the closure.
  - stay about the same for Rigid Plastic 2 as higher burdens from incineration than resulting energy credits are combined with lower burdens from material recycling than material credits.
  - stay about the same for Glass jar 1 as most of the recycled glass is used in a closed loop, being not effected by allocation.

# Baby food, Europe

## comparative results



Baby food, Europe, Allocation 0	The net results of Tetra Recart® 3x8 WAIF 100g are lower (green)/ higher (orange) than those of		
	Pouch 2 with cap 100g	Rigid plastic 2 100g	Glass jar 1 100g
Climate Change	-47%	-28%	-69%
Acidification	-25%	+14%	-62%
Photo-Oxidant Formation	-23%	+18%	-59%
Ozone Depletion Potential	-52%	+106%	-20%
Terrestrial Eutrophication	-23%	+27%	-58%
Aquatic Eutrophication	-17%	+239%	+54%
Particulate Matter	-24%	+17%	-63%
Use of Nature	+322%	+698%	+474%

Baby food, Europe, Allocation 50	The net results of Tetra Recart® 3x8 WAIF 100g are lower (green)/ higher (orange) than those of		
	Pouch 2 with cap 100g	Rigid plastic 2 100g	Glass jar 1 100g
Climate Change	-41%	-17%	-62%
Acidification	-27%	+13%	-63%
Photo-Oxidant Formation	-23%	+19%	-60%
Ozone Depletion Potential	-52%	+112%	-20%
Terrestrial Eutrophication	-24%	+27%	-58%
Aquatic Eutrophication	-21%	+229%	+43%
Particulate Matter	-25%	+17%	-64%
Use of Nature	+270%	+599%	+401%

Baby food, Europe, Allocation 100	The net results of Tetra Recart® 3x8 WAIF 100g are lower (green)/ higher (orange) than those of		
	Pouch 2 with cap 100g	Rigid plastic 2 100g	Glass jar 1 100g
Climate Change	-36%	-6%	-56%
Acidification	-28%	+13%	-65%
Photo-Oxidant Formation	-24%	+20%	-61%
Ozone Depletion Potential	-52%	+118%	-20%
Terrestrial Eutrophication	-25%	+28%	-59%
Aquatic Eutrophication	-25%	+217%	+33%
Particulate Matter	-26%	+17%	-66%
Use of Nature	+217%	+498%	+328%

- Main conclusions considering results with all allocation factors:
  - Tetra Recart® 3x8 WAIF shows lower impacts for all impact categories except 'Use of nature' than Pouch 2 with cap.
  - Tetra Recart® 3x8 WAIF shows lower impacts for all impact categories except 'Use of nature' and 'Aquatic Eutrophication' than Glass jar 1.
  - Tetra Recart® 3x8 WAIF shows higher impacts for all impact categories except 'Climate Change' than Rigid plastic 2.
  - Tetra Recart® 3x8 WAIF shows higher impacts for 'Use of Nature' than all regarded competing packaging systems.

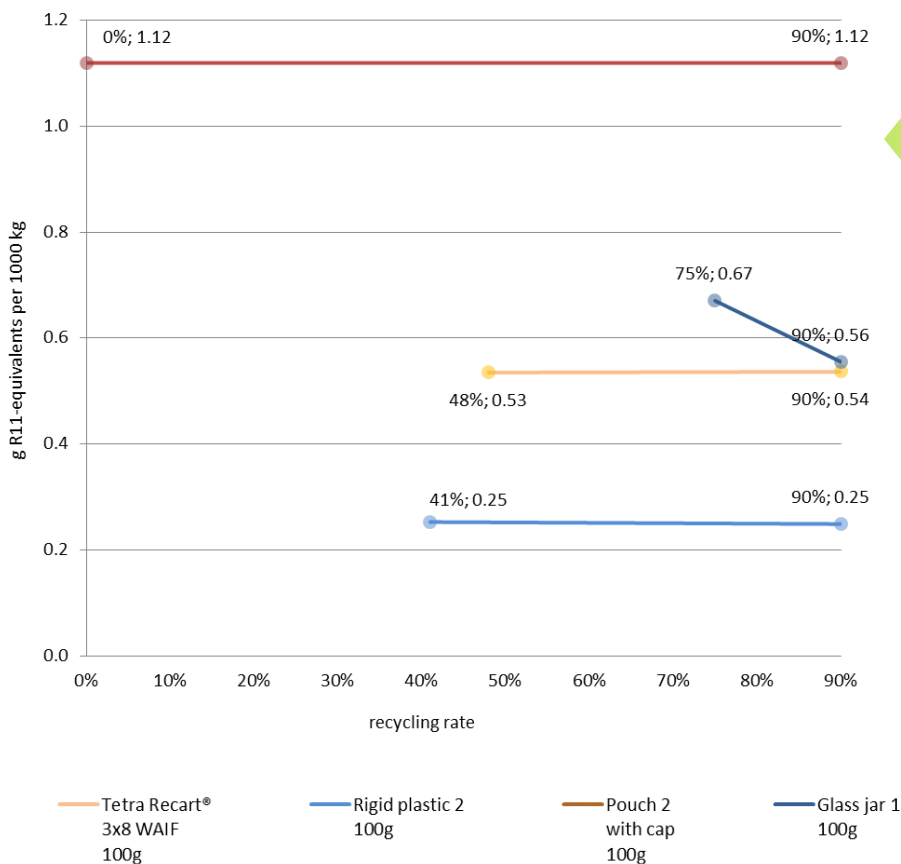
● 26		Tetra Recart® better than alternative packaging system
		Tetra Recart® similar as alternative packaging system
		Tetra Recart® worse than alternative packaging system

# Baby food Europe

## scenario variant - recycling rate



### Ozone Depletion



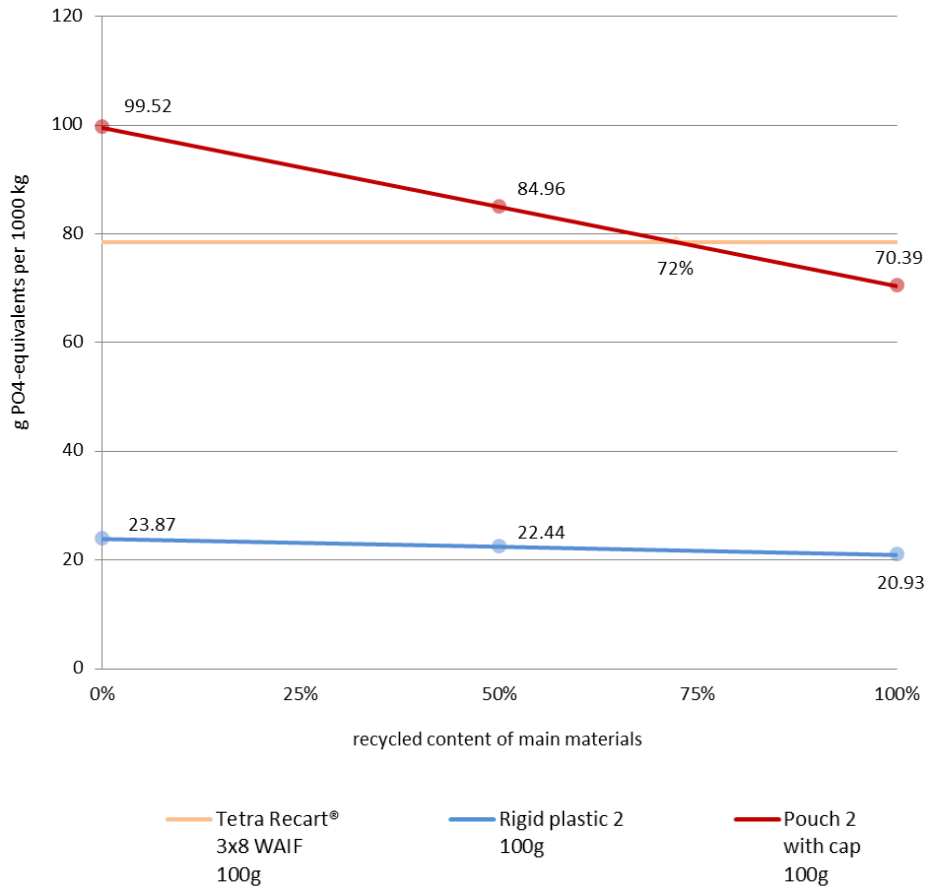
- Scenario variants regarding recycling rate change the comparative conclusions in this segment in the following cases:
- 'Ozone Depletion': The increase of the recycling rate to 90% leads so similar net results for the Tetra Recart® 3x8 WAIF and the Glass jar 1.

# Baby food Europe

## scenario variant - recycled content



### Aquatic Eutrophication



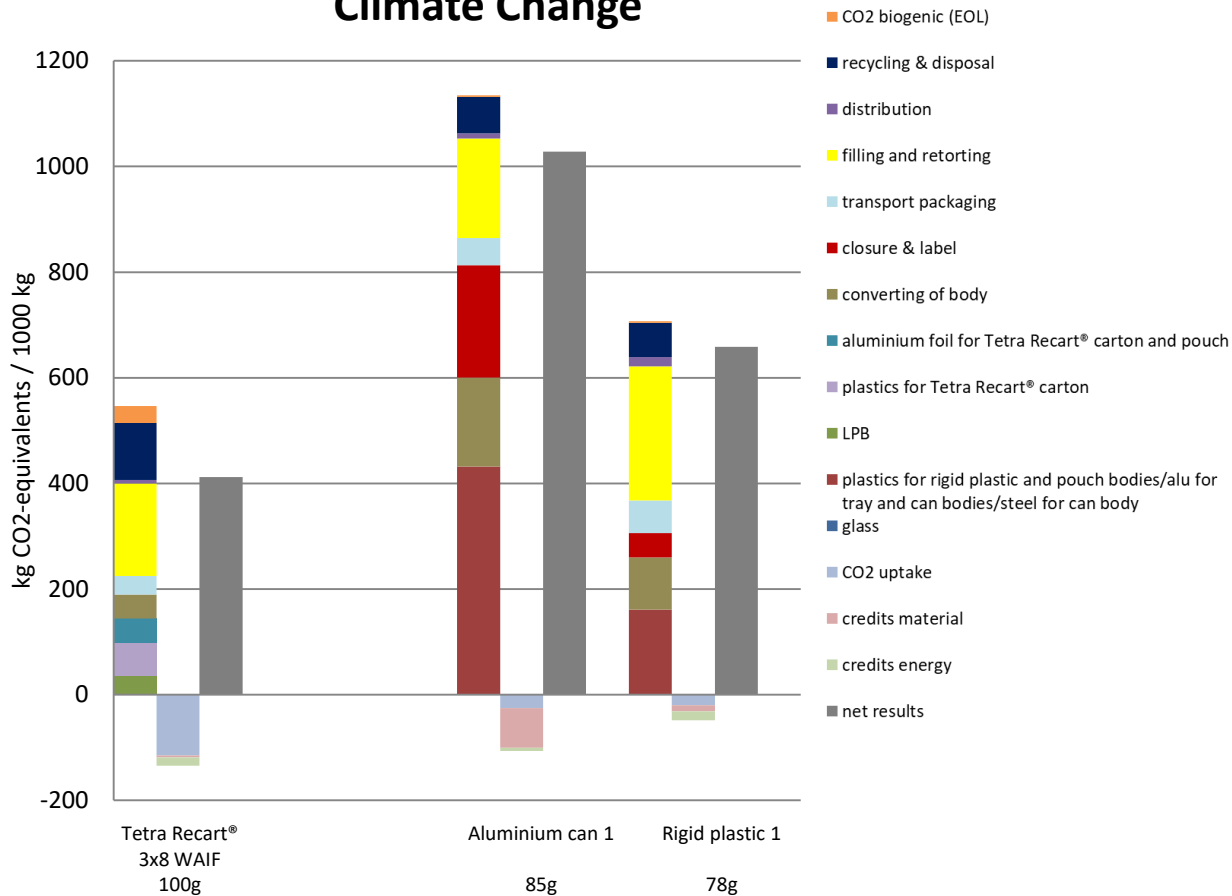
- Scenario variants regarding recycled content change the comparative conclusions in this segment in the following cases:
  - 'Aquatic Eutrophication': Pouch 2 with cap breaks even with the Tetra Recart® with a share of recycled content in its main materials of 72%, leading to similar net results in this comparison.
  - 'Climate Change': The increase of recycled content of Rigid plastic 2 does not lead to a break-even point with the Tetra Recart® but is leading to similar net results in this comparison.

# Pet food USA

## contribution analysis allocation 50% - Climate Change



### Climate Change



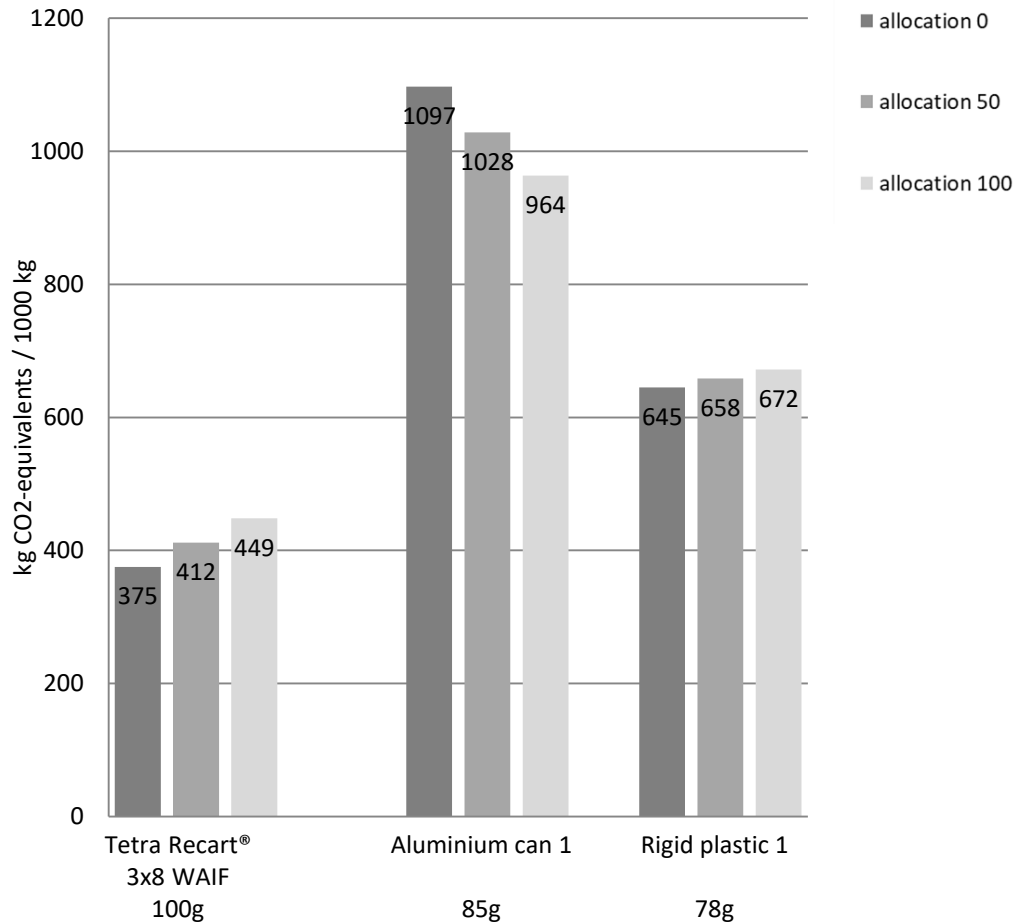
- The following life cycle steps have a share of total Climate Change burdens higher than 20%:
  - Tetra Recart®:
    - filling and retorting: 32%
    - raw materials body (LPB, plastics, aluminium foil): 26%
    - recycling & disposal + CO2 biogenic (EOL): 26%
  - Aluminium can 1:
    - raw materials (aluminium): 38%
  - Rigid plastic 1:
    - filling and retorting: 36%
    - raw materials (plastics, aluminium foil): 23%

# Pet food USA

allocation 0%, 50%, 100% - Climate Change



## Climate Change



- Regarding Climate Change, with higher allocation factors, net results
  - increase for Tetra Recart® due to the higher allocation of biogenic CO<sub>2</sub> emissions.
  - decrease for Aluminium can as material credits are higher than burdens from material recycling.
  - stay about the same for Rigid Plastic 1 as higher burdens from incineration than resulting energy credits are combined with lower burdens from material recycling than material credits.

# Pet food, USA comparative results



Pet food, USA, Allocation 0	The net results of <b>Tetra Recart® 3x8 WAIF 100g</b> are lower (green)/ higher (orange) than those of	
	Aluminium can 1 85g	Rigid plastic 1 78g
Climate Change	-66%	-42%
Acidification	-66%	-29%
Photo-Oxidant Formation	-55%	-17%
Ozone Depletion Potential	+48%	+6%
Terrestrial Eutrophication	-51%	-13%
Aquatic Eutrophication	+117%	-11%
Particulate Matter	-62%	-25%
Use of Nature	+272%	+311%

Pet food, USA, Allocation 50	The net results of <b>Tetra Recart® 3x8 WAIF 100g</b> are lower (green)/ higher (orange) than those of	
	Aluminium can 1 85g	Rigid plastic 1 78g
Climate Change	-60%	-37%
Acidification	-63%	-29%
Photo-Oxidant Formation	-53%	-16%
Ozone Depletion Potential	+54%	+7%
Terrestrial Eutrophication	-48%	-12%
Aquatic Eutrophication	+116%	-8%
Particulate Matter	-60%	-24%
Use of Nature	+252%	+285%

Pet food, USA, Allocation 100	The net results of <b>Tetra Recart® 3x8 WAIF 100g</b> are lower (green)/ higher (orange) than those of	
	Aluminium can 1 85g	Rigid plastic 1 78g
Climate Change	-53%	-33%
Acidification	-60%	-29%
Photo-Oxidant Formation	-49%	-15%
Ozone Depletion Potential	+60%	+8%
Terrestrial Eutrophication	-44%	-12%
Aquatic Eutrophication	+114%	-5%
Particulate Matter	-56%	-24%
Use of Nature	+232%	+259%

- Main conclusions considering results with all allocation factors:
  - **Tetra Recart® 3x8 WAIF** shows lower impacts for all impact categories except ‘Ozone Depletion Potential’, ‘Aquatic Eutrophication’ and ‘Use of nature’ than all regarded competing packaging systems.
  - **Tetra Recart® 3x8 WAIF** shows higher impacts for ‘Use of Nature’ than all regarded competing packaging systems.

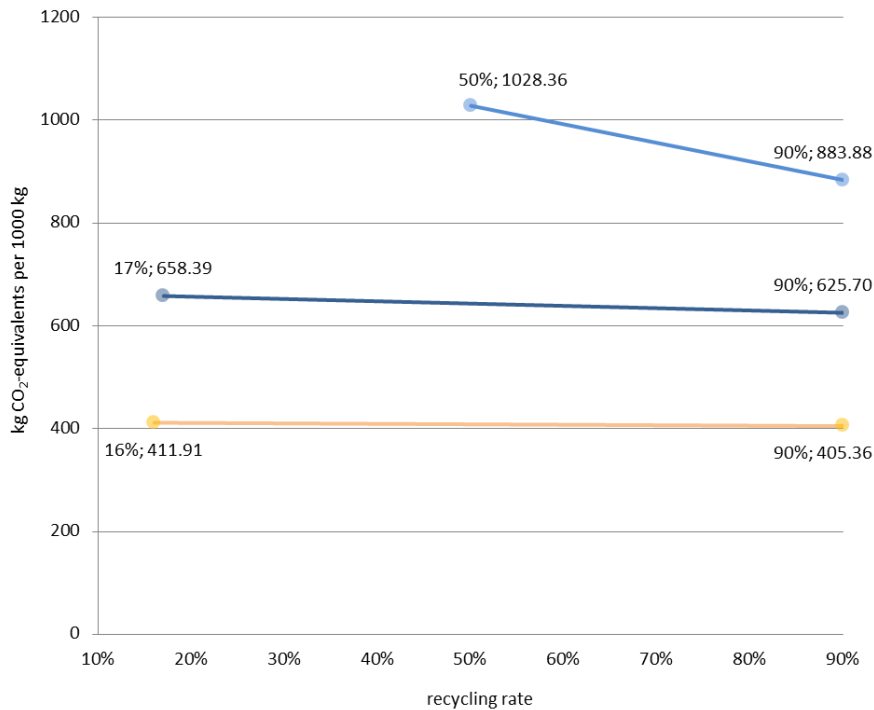
● 31		Tetra Recart® better than alternative packaging system
		Tetra Recart® similar as alternative packaging system
		Tetra Recart® worse than alternative packaging system

# Pet food USA

## scenario variant – recycling rate



### Climate Change



- Scenario variants regarding recycling rate do not change the comparative conclusions in this segment.
- Exemplary graph for 'Climate Change'



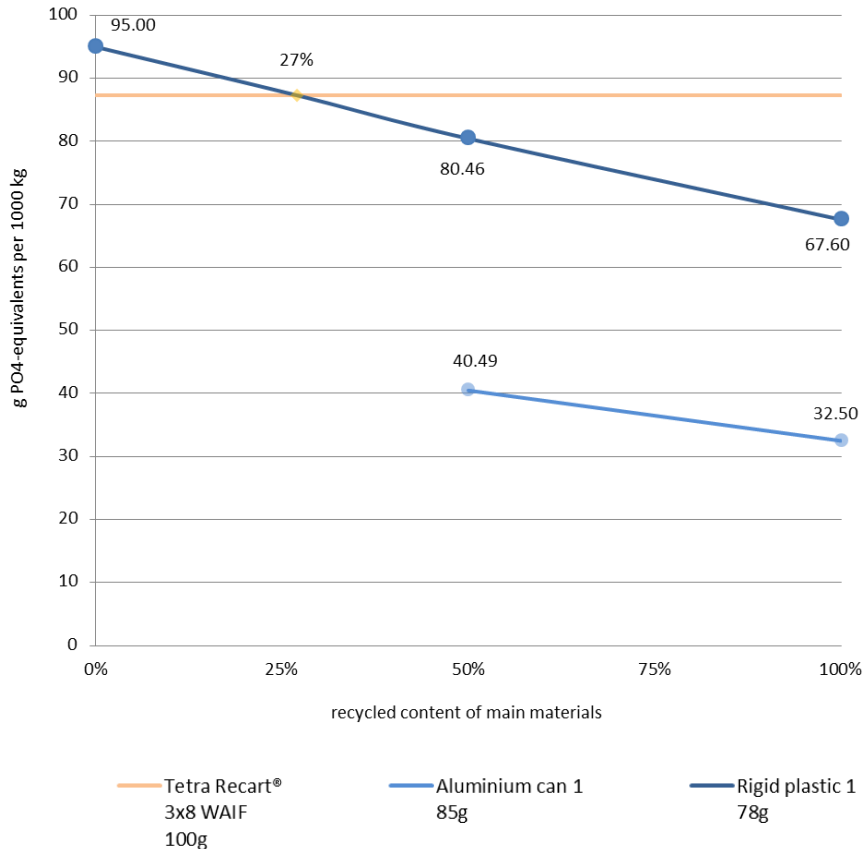


# Pet food USA

## scenario variant - recycled content



### Aquatic Eutrophication



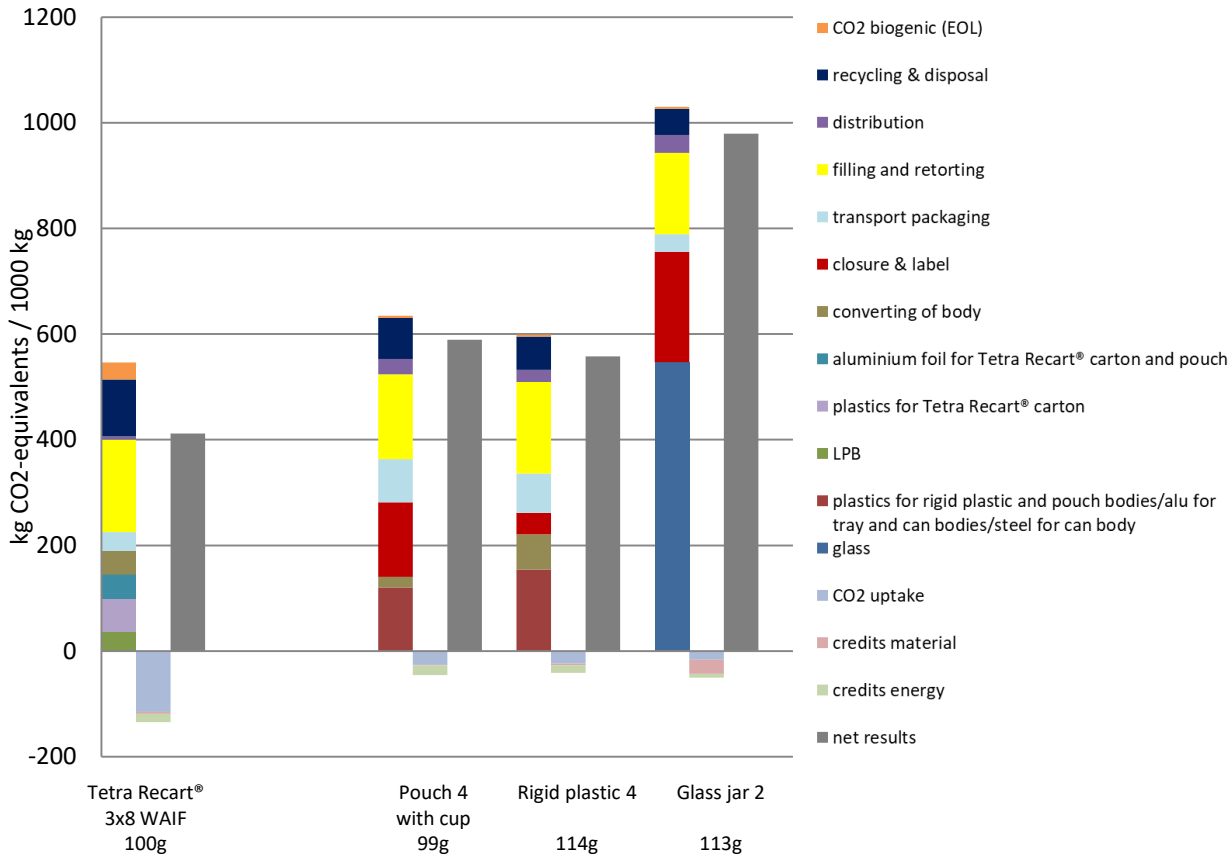
- Scenario variants regarding recycled content change the comparative conclusions in this segment in the following cases:
  - 'Aquatic Eutrophication': Rigid plastic 1 breaks even with the Tetra Recart® with a share of recycled content in its main materials of 31% leading to higher net results for the Tetra Recart®.
  - 'Terrestrial Eutrophication': Rigid plastic 1 breaks even with the Tetra Recart® with share of recycled content in its main materials of 64% leading to similar net results.
  - 'Particulate Matter': Rigid plastic 1 breaks even with the Tetra Recart® with a share of recycled content in its main materials of 78% leading to similar net results.
  - 'Acidification': Rigid plastic 1 breaks even with the Tetra Recart® with a share of recycled content in its main materials of 79% leading to similar net results.

# Baby food USA

## contribution analysis allocation 50% - Climate Change



### Climate Change



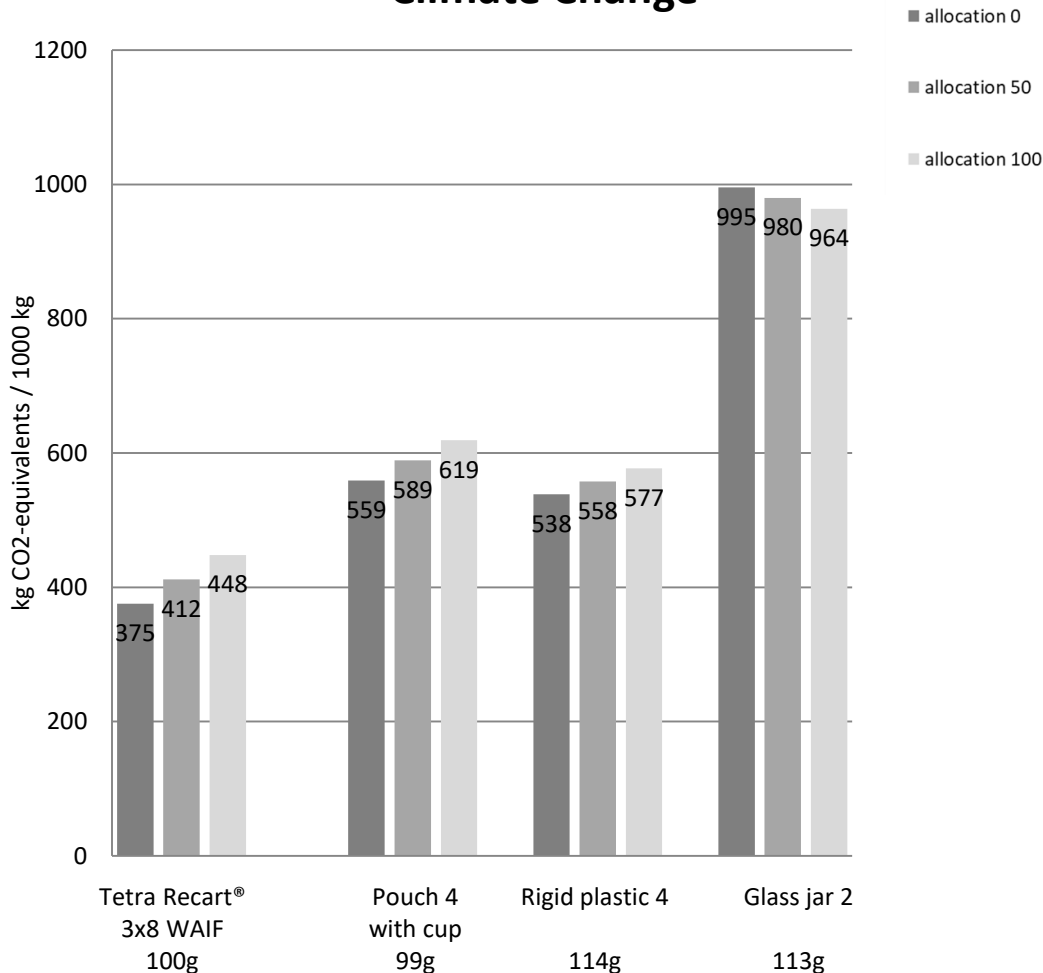
- The following life cycle steps have a share of total Climate Change burdens higher than 20%:
  - Tetra Recart®:
    - filling and retorting: 32%
    - raw materials body (LPB, plastics, aluminium foil): 26%
    - recycling & disposal + CO2 biogenic (EOL): 26%
  - Pouch 4 with cap
    - filling and retorting: 25%
    - closure: 22%
  - Rigid plastic 4:
    - filling and retorting: 29%
    - raw materials (plastics): 26%
  - Glass jar 2:
    - raw materials (glass): 53%

# Baby food USA

allocation 0%, 50%, 100% - Climate Change



## Climate Change



- Regarding Climate Change, with higher allocation factors, net results
  - increase for Tetra Recart® due to the higher allocation of biogenic CO<sub>2</sub> emissions.
  - increase for Pouch 4 with cap and Rigid Plastic 4 as burdens from incineration are higher than resulting energy credits.
  - stay about the same for Glass jar 2 as most of the recycled glass is used in a closed loop, being not effected by allocation.

# Baby food, USA

## comparative results



Baby food, USA, Allocation 0	The net results of Tetra Recart® 3x8 WAIF 100g are lower (green)/ higher (orange) than those of		
	Pouch 4 with cap 99g	Rigid plastic 4 114g	Glass jar 2 113g
Climate Change	-33%	-30%	-62%
Acidification	+4%	-10%	-61%
Photo-Oxidant Formation	-6%	+4%	-60%
Ozone Depletion Potential	-52%	+99%	-43%
Terrestrial Eutrophication	-5%	+8%	-59%
Aquatic Eutrophication	-24%	+71%	-2%
Particulate Matter	+2%	-4%	-65%
Use of Nature	+212%	+243%	+982%

Baby food, USA, Allocation 50	The net results of Tetra Recart® 3x8 WAIF 100g are lower (green)/ higher (orange) than those of		
	Pouch 4 with cap 99g	Rigid plastic 4 114g	Glass jar 2 113g
Climate Change	-30%	-26%	-58%
Acidification	+3%	-11%	-61%
Photo-Oxidant Formation	-7%	+3%	-59%
Ozone Depletion Potential	-52%	+102%	-42%
Terrestrial Eutrophication	-6%	+7%	-58%
Aquatic Eutrophication	-25%	+69%	-5%
Particulate Matter	+1%	-5%	-65%
Use of Nature	+192%	+221%	+915%

Baby food, USA, Allocation 100	The net results of Tetra Recart® 3x8 WAIF 100g are lower (green)/ higher (orange) than those of		
	Pouch 4 with cap 99g	Rigid plastic 4 114g	Glass jar 2 113g
Climate Change	-28%	-22%	-53%
Acidification	+2%	-11%	-61%
Photo-Oxidant Formation	-7%	+2%	-59%
Ozone Depletion Potential	-52%	+105%	-41%
Terrestrial Eutrophication	-7%	+6%	-58%
Aquatic Eutrophication	-27%	+66%	-8%
Particulate Matter	+1%	-6%	-65%
Use of Nature	+172%	+199%	+847%

- Main conclusions considering results with both allocation factors:
  - Tetra Recart® 3x8 WAIF shows lower impacts for ‘Climate Change’ than all regarded competing packaging systems.
  - Tetra Recart® 3x8 WAIF shows lower impacts for ‘Climate Change’, ‘Ozone Depletion Potential’ and ‘Aquatic Eutrophication’ than Pouch 4 with cap.
  - Tetra Recart® 3x8 WAIF shows lower impacts for ‘Climate Change’ and ‘Acidification’ than Rigid plastic 4.
  - Tetra Recart® 3x8 WAIF shows lower impacts for all impact categories except ‘Use of nature’ and ‘Aquatic Eutrophication’ than Glass jar 2.
  - Tetra Recart® 3x8 WAIF shows higher impacts for ‘Use of Nature’ than all regarded competing packaging systems.

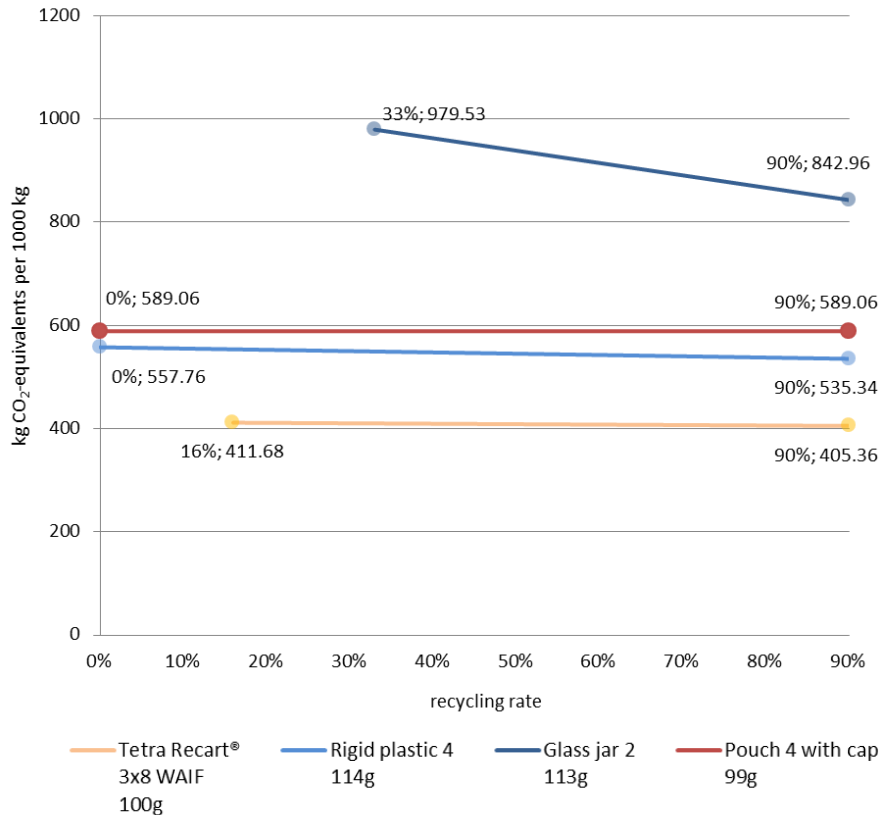
● 36	<span style="background-color: #90EE90; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> Tetra Recart® better than alternative packaging system
	<span style="background-color: #D3D3D3; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> Tetra Recart® similar as alternative packaging system
	<span style="background-color: #FFA500; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> Tetra Recart® worse than alternative packaging system

# Baby food USA

## scenario variant – recycling rate



### Climate Change



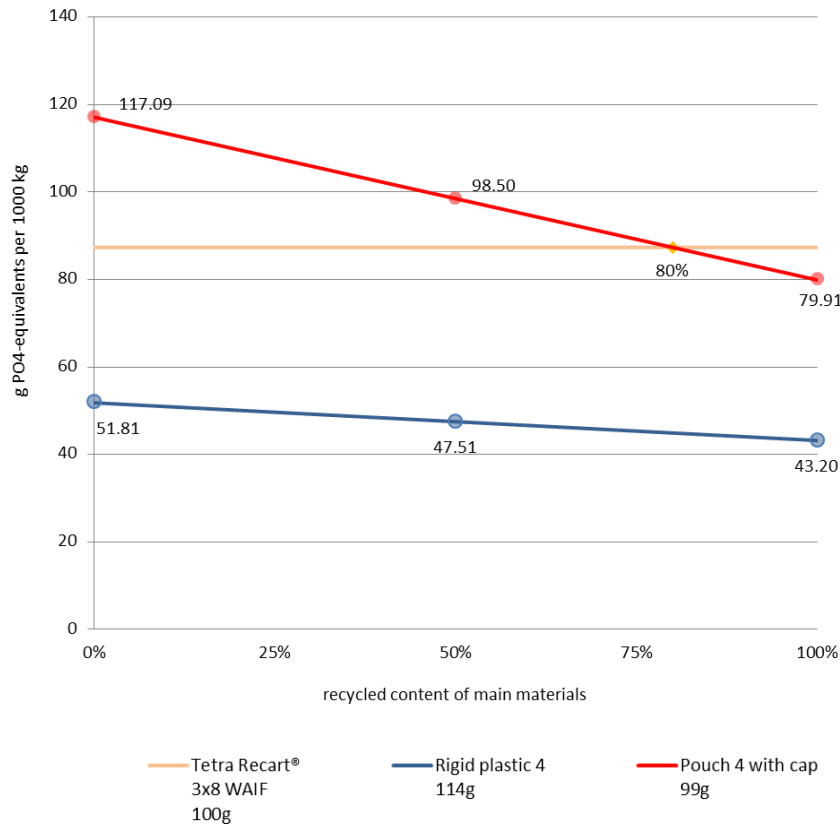
- Scenario variants regarding recycling rate do not change the comparative conclusions in this segment.
- Exemplary graph for 'Climate Change'

# Baby food USA

## scenario variant - recycled content



### Aquatic Eutrophication

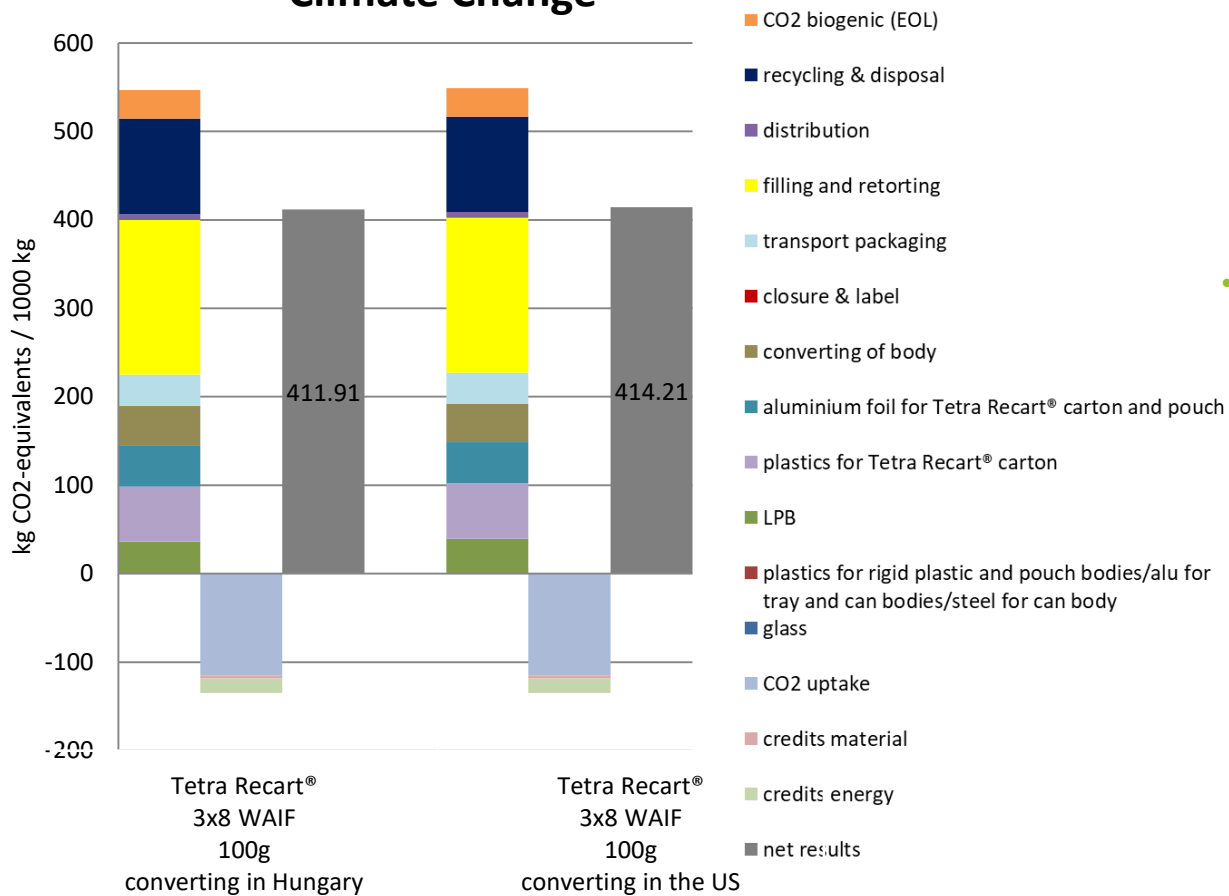


- Scenario variants regarding recycled content change the comparative conclusions in this segment in the following cases:

- 'Aquatic Eutrophication': Pouch 4 with cap breaks even with the Tetra Recart® with a share of recycled content in its main materials of 80% leading to similar net results in this comparison.
- 'Acidification': Rigid plastic 4 breaks even with the Tetra Recart® with a share of recycled content in its main materials of 36% leading to higher net results for the Tetra Recart®.



### Climate Change



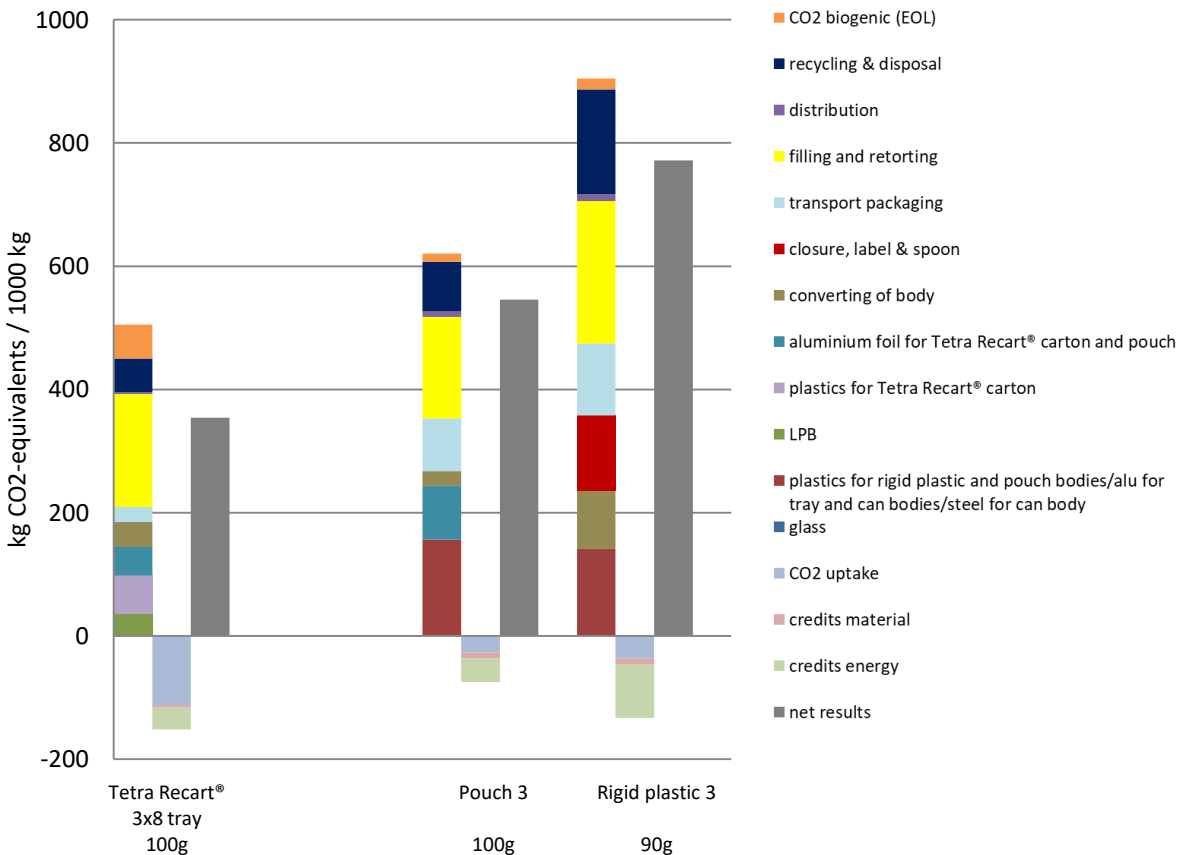
- In the base scenarios the Tetra Recart® cartons for all regarded markets are converted in Hungary. In case of the US market a scenario variant is calculated with the converting process taken place in the USA. Regarding the raw materials for the Tetra Recart® carton, LPB and aluminium foil are imported from Europe, whereas plastics<sup>1</sup> are produced in the USA.
- only minor differences are shown for the comparison of the Tetra Recart's® production locations in Hungary and in the US.

# Baby food Japan

## contribution analysis allocation 50% - Climate Change



### Climate Change



- The following life cycle steps have a share of total Climate Change burdens higher than 20%:

- Tetra Recart®:
  - filling and retorting: 36%
  - raw materials body (LPB, plastics, aluminium foil): 29%
  - recycling & disposal + CO2 biogenic (EOL): 22%
- Pouch 3
  - filling and retorting: 26%
  - raw materials (plastics, aluminium foil): 39%
- Rigid plastic 3:
  - filling and retorting: 27%
  - raw materials (plastics): 25%
  - recycling & disposal + CO2 biogenic (EOL): 21%

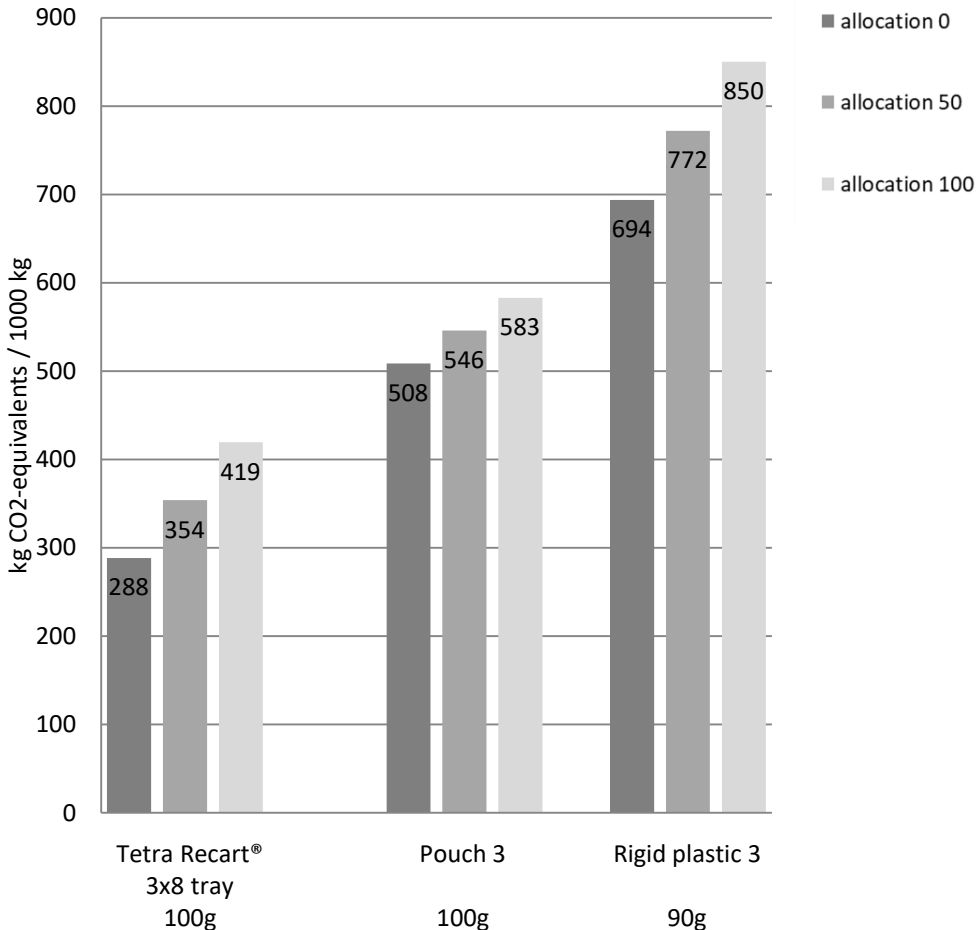


# Baby food Japan

allocation 0%, 50%, 100% - Climate Change



## Climate Change



- Regarding Climate Change, with higher allocation factors, net results
  - increase for Tetra Recart® due to the higher allocation of biogenic CO<sub>2</sub> emissions.
  - increase for Pouch 3 and Rigid Plastic 3 as burdens from incineration and fuel substitution are higher than resulting energy credits.

# Baby food, Japan

## comparative results



<i>Baby food, Japan, Allocation 0</i>	The net results of <b>Tetra Recart® 3x8 tray 100g</b> are lower (green)/ higher (orange) than those of	
	Pouch 3 100g	Rigid plastic 3 90g
Climate Change	-43%	-58%
Acidification	-1%	-37%
Photo-Oxidant Formation	+2%	-32%
Ozone Depletion Potential	-66%	-5%
Terrestrial Eutrophication	-6%	-29%
Aquatic Eutrophication	-2%	-34%
Particulate Matter	+1%	-35%
Use of Nature	+184%	+106%

<i>Baby food, Japan, Allocation 50</i>	The net results of <b>Tetra Recart® 3x8 tray 100g</b> are lower (green)/ higher (orange) than those of	
	Pouch 3 100g	Rigid plastic 3 90g
Climate Change	-35%	-54%
Acidification	-2%	-38%
Photo-Oxidant Formation	+2%	-31%
Ozone Depletion Potential	-66%	-1%
Terrestrial Eutrophication	-6%	-29%
Aquatic Eutrophication	-5%	-35%
Particulate Matter	+0%	-35%
Use of Nature	+161%	+89%

<i>Baby food, Japan, Allocation 100</i>	The net results of <b>Tetra Recart® 3x8 tray 100g</b> are lower (green)/ higher (orange) than those of	
	Pouch 3 100g	Rigid plastic 3 90g
Climate Change	-28%	-51%
Acidification	-3%	-38%
Photo-Oxidant Formation	+1%	-31%
Ozone Depletion Potential	-66%	+4%
Terrestrial Eutrophication	-7%	-28%
Aquatic Eutrophication	-8%	-36%
Particulate Matter	-1%	-34%
Use of Nature	+138%	+72%

- Main conclusions considering results with both allocation factors:
  - **Tetra Recart® 3x8 tray** shows lower impacts for ‘Climate Change’ and ‘Ozone Depletion Potential’, than **Pouch 3**.
  - **Tetra Recart® 3x8 tray** shows lower impacts for all impact categories except ‘Use of nature’ and ‘Ozone Depletion Potential’ than **Rigid plastic 3**.
  - **Tetra Recart® 3x8 tray** shows higher impacts for ‘Use of Nature’ than all regarded competing packaging systems.

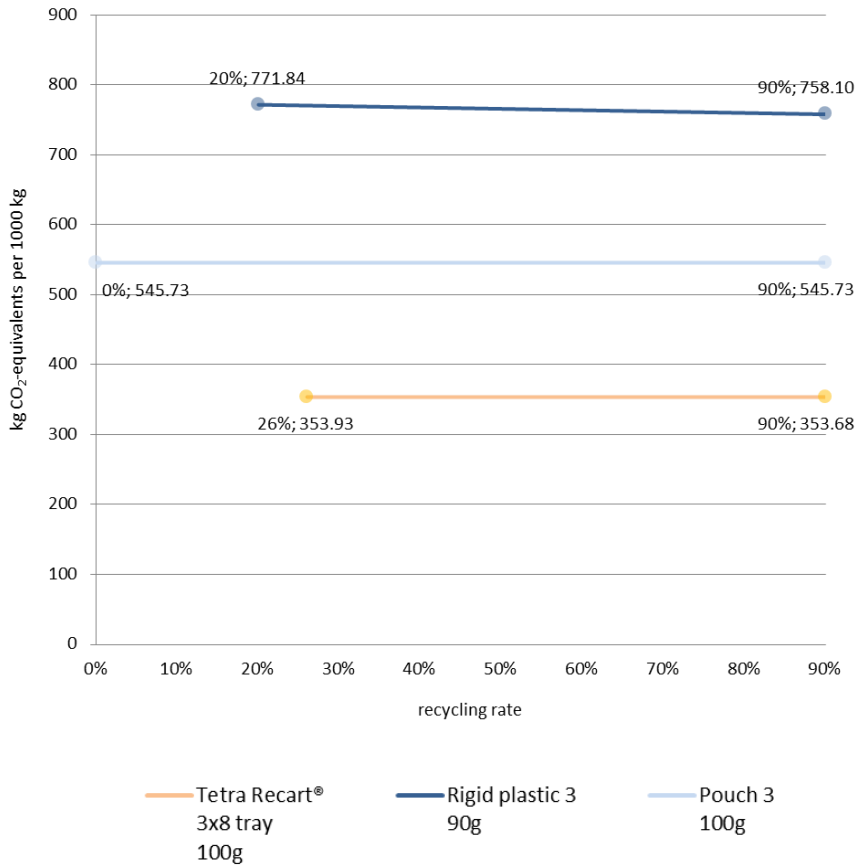
● 42		Tetra Recart® better than alternative packaging system
		Tetra Recart® similar as alternative packaging system
		Tetra Recart® worse than alternative packaging system

# Baby food Japan

## scenario variant - recycling rate



Climate Change



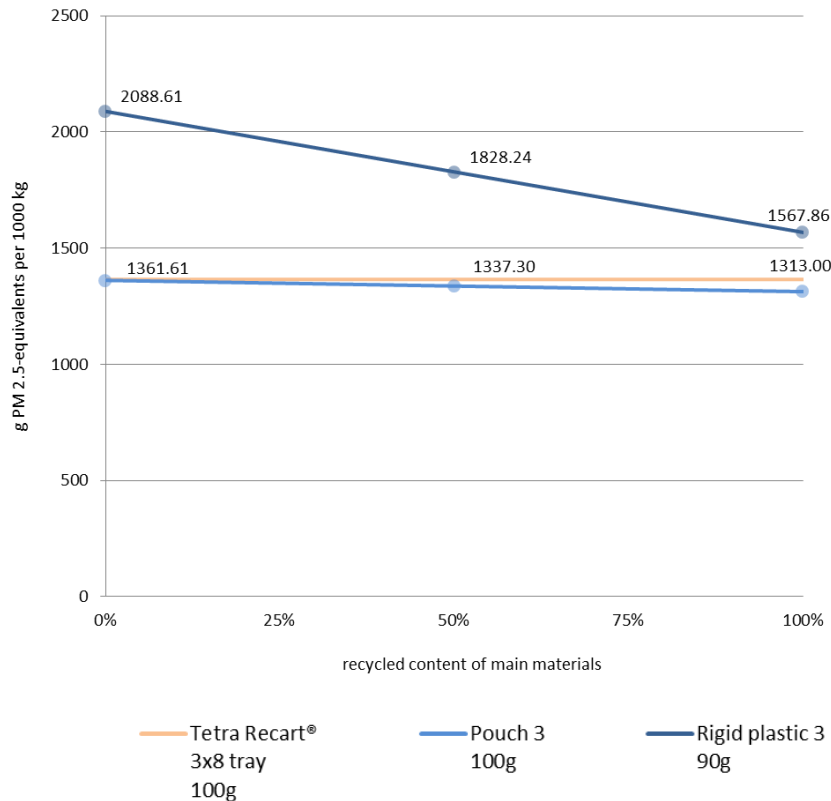
- Scenario variants regarding recycling rate do not change the comparative conclusions in this segment.
- Exemplary graph for 'Climate Change'

# Baby food Japan

## scenario variant - recycled content



### Particulate Matter: PM 2.5



- Scenario variants regarding recycled content change the comparative conclusions in this segment in the following case:
- 'Particulate Matter': The increase of recycled content of Rigid plastic 3 does not lead to a break-even point with the Tetra Recart® but is leading to similar net results in this comparisons.

# Overall results

## Climate Change



		TRC option	Pouch 1 100g	Alu tray 1 100g	Steel can 1 100g	Pouch 2 with cap 100g	Rigid plastic 2 100g	Glass jar 1 100g	Alu can 1 85g	Rigid plastic 1 78g	Pouch 4 with cap 99g	Rigid plastic 4 114g	Glass jar 2 113g	Pouch 3 100g	Rigid plastic 3 100g	
EUROPE	Allocation: 50% Pet food	TRC 3x8 WAIF 100g	-20%	-27%	-72%											
		TRC 2x4 sales unit 100g	-15%	-23%	-70%											
	Allocation: 100% Pet food	TRC 3x8 WAIF 100g	-10%	-9%	-55%											
		TRC 2x4 sales unit 100g	-5%	-3%	-53%											
	Allocation: 50% Baby food	TRC 3x8 WAIF 100g				-41%	-17%	-62%								
	Allocation: 100% Baby food	TRC 3x8 WAIF 100g				-36%	-6%	-56%								
US	Allocation: 50% Pet food	TRC 3x8 WAIF 100g							-60%	-37%						
	Allocation: 100% Pet food	TRC 3x8 WAIF 100g							-53%	-33%						
	Allocation: 50% Baby food	TRC 3x8 WAIF 100g									-30%	-26%	-58%			
	Allocation: 100% Baby food	TRC 3x8 WAIF 100g									-28%	-22%	-53%			
JAPAN	Allocation: 50% Baby food	TRC 3x8 tray 100g												-35%	-54%	
	Allocation: 100% Baby food	TRC 3x8 tray 100g												-28%	-51%	

● 45		Tetra Recart® better than alternative packaging system
		Tetra Recart® similar as alternative packaging system
		Tetra Recart® worse than alternative packaging system

# Overall results - all impact categories

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- The results of the comparisons of Tetra Recart® cartons with competing packaging systems are diverse between the different segments and packaging systems. Therefore, for conclusions regarding the comparative performances of Tetra Recart® cartons, the detailed comparative result section of each segment and market should be consulted.
- General conclusions can be drawn regarding
  - ‘Climate Change’, in which the Tetra Recart® cartons show lower impacts than most compared alternative packaging systems.
  - ‘Use of Nature’, in which the Tetra Recart® cartons show substantial higher impacts than the compared alternative packaging systems.
    - ‘Use of Nature’ covers preservation of biodiversity and ecosystems. The methodology is based on the hemeroby concept (distance to nature) and classifies different land use types based on their occupation impact. That means that forest area receives a lower characterisation factor than agricultural systems. A sustainably managed area, like FSC certified forest, shows the lowest characterisation factor apart from untouched natural land. The highest factor is used for sealed roads or coal mining pits.



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