INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

SIGNATURE **portfolio**

Extension: Analysis of combibloc **ECO**PLUS & **SIG**NATURE 100 and **SIG**NATURE FULL BARRIER for combiblocMidi on the Polish market

Comparative life cycle assessment of beverage cartons containing polymers based on the mass-balanced renewable material approach

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1 Introduction

The focus of the main report is to investigate combiblocSlimline (cb3) and combiblocMidi (cb8) cartons on the European market. In this extension, the selection of beverage cartons listed in **Table 1-1** and **Table 1-2**, which were already examined in the main report, are evaluated again with country-specific parameters for Poland (same material composition, same weight). The comparisons of the beverage cartons are structured according to the same scheme.

As the SIG packaging combifitMidi (cf8) is identical to the combiblocMidi (cb8) with regard to all packaging specifications (including secondary and tertiary packaging), the results of the combiblocMidi (cb8) 1000 mL also apply to the combifitMidi (cf8) 1000 mL, correspondingly, the results of the combiblocMidi (cb8) 500 mL also apply to the combifitMidi 500 mL..

The following abbreviations, which are included in the packaging names are applied in this study:

- combiblocMidi (cb8)
- Standard RS (robust structure)
- cSwift (combiSwift)
- **SIG**NATURE PACK FB (full barrier, containing aluminium)
- **SIG**NATURE PACK 100 (100% mass-balanced PE, PP, PA)

Table 1-1: List of beverage cartons examined in Poland (1000 mL)

combiblocMidi (cb8) beverage cartons and closure
cb8 standard RS (cSwift)
cb8 EcoPlus (cSwift LP)

Table 1-2: List of beverage cartons examined in Poland (500 mL)

combiblocMidi (cb8) beverage cartons and closure
cb8 standard RS (cSwift)
cb8 EcoPlus (cSwift LP)

This extension focusses only on one environmental impact category, ‘Climate Change’. Impacts on ‘Climate Change’ depend strongly on local settings like end-of-life processes or the local electricity mix. For other environmental impact categories, please refer to the results regarding the European market that are presented in the main report.

The following parameters correspond to the parameters of the main report on the European market:

- Functional unit
- System boundaries
- Data gathering and data quality
- Methodological aspects (mass-balanced renewable material approach, allocation, biogenic carbon)
- Manufacture of raw materials
- Process data for converting and filling
- Electricity mix for converting process

Adjusted parameters for the geographic scope of the extension are:

- Distribution
- End-of-life
- Electricity mix for filling, recycling processes and credits
- Electrical and thermal efficiencies of the municipal waste incineration
- Landfill gas recovery rates

2 Adjusted parameters

2.1 Distribution

Table 2-1 shows the applied distribution distances in this extension. The distribution distances for the Polish market from filling to POS were provided by SIG Combibloc.

Table 2-1: Distribution distances in Poland for the examined packaging systems

	Distribution distance			
	Distribution Step 1		**Distribution step 2**	
Market	**Filler → distribution centre** (delivery)	**Distribution centre → filler** (return trip)	**Distribution centre → POS** (delivery)	**POS → distribution centre** (return trip)
Poland	200 km	60 km	30 km	30 km

2.2 End-of-life

To model the end-of-life of the examined beverage cartons one needs to know their fate after their use by the consumers. It is aimed to apply the recycling rate and disposal split for the beverage cartons of the Polish market. These data has been collected from different waste management reports and statistics. For beverage cartons specific recycling rates are publicly available for the market examined.

The applied recycling rate and the disposal split for Poland are listed in **Table 2-2**.

Table 2-2: End-of-life split of beverage cartons examined

Poland		Source
Recycling rate		
Beverage cartons	confidential	(EXTR:ACT 2020)
Disposal split		
Landfill	64.9%	(Eurostat 2021) municipal waste statistic, data for 2019
Incineration	35.1%	

2.3 Electricity mix

Modelling of electricity generation is particularly relevant for the production of base materials as well as for filling, recycling processes and credits. Electric power supply is modelled using country specific grid electricity mixes, since the environmental burdens of power production varies strongly depending on the electricity generation technology. A more detailed description is given in **section 3.9.2**. of the main report.

The emission factor (Climate Change) for Poland is 987 g/kWh for the electricity mix used (reference year 2018) (Fehrenbach et al. 2016; IEA 2018), while the average EU electricity mix is 416 g/kWh. This means that the Polish electricity mix is responsible for around 58% higher greenhouse gas emissions than the European one. This is mainly due to the high amount of lignite used in the Polish electricity production.

2.4 Municipal waste incineration

The electrical and thermal efficiencies of the municipal solid waste incineration plants (MSWI) are shown in table **Table 2-3**.

Table 2-3: Electrical and thermal efficiencies of the incineration plants for Poland

Geographic Scope	Electrical efficiency	Thermal efficiency	Reference period	Source
Poland	13.4%	45.2%	2012	(Cyranka et al. 2016)

The efficiencies are used as parameters for the incineration model, which assumes a technical standard (especially regarding flue gas cleaning) that complies with the requirements given by the EU incineration directive (EU 2018). It is assumed that the electric energy generated in MSWI plants substitutes market specific grid electricity. Furthermore, it is assumed that the thermal energy recovered in MSWI plants is used as process heat.

3 Results and discussion

3.1 Poland combiblocMidi (cb8) beverage cartons 1000 mL

3.1.1 Scenario I (50% allocation): numerical values and graphs

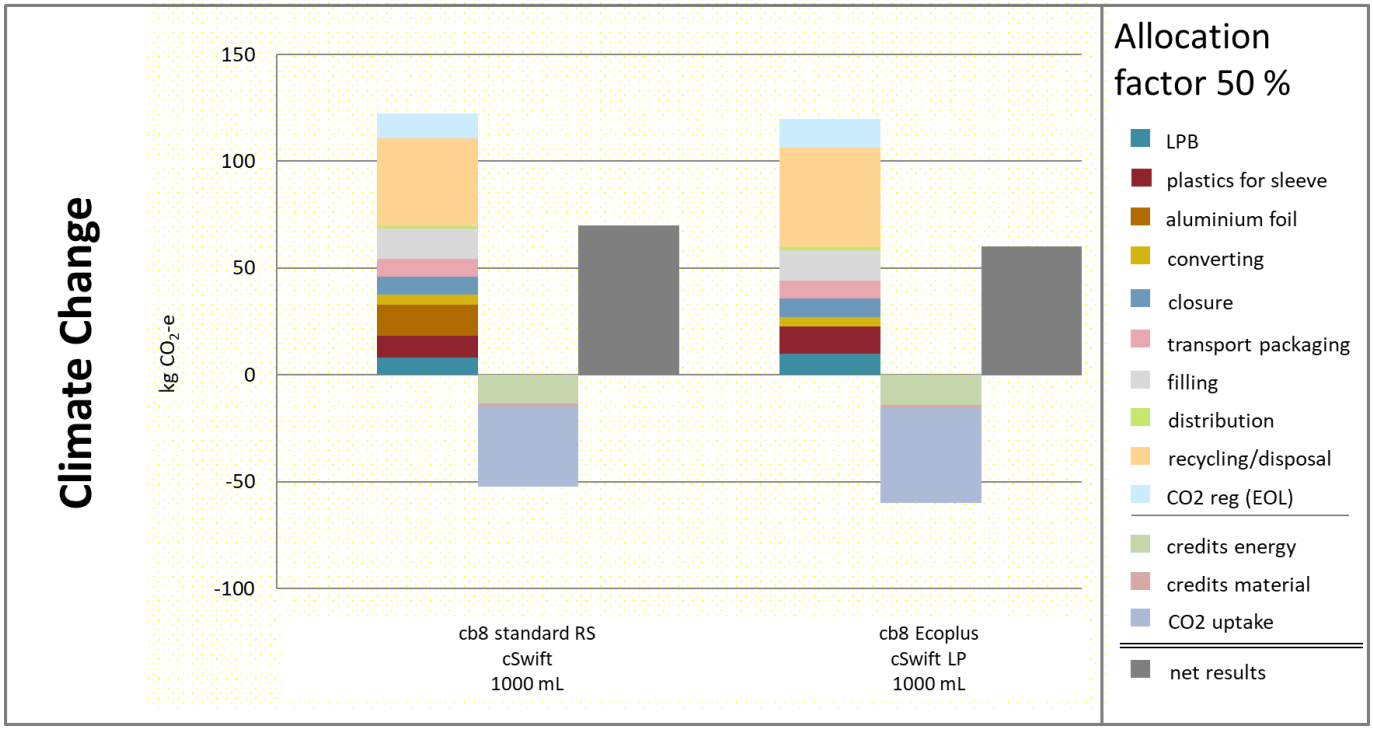

Figure 3-1: Climate Change results of **scenario I Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 50%

Table 3-1: Climate Change results of **scenario I Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 50%: burdens, credits and net results per functional unit of 1000 L beverage

Scenario I Poland, allocation factor 50 %		cb8 standard RS cSwift 1000 mL	cb8 EcoPlus cSwift LP 1000 mL
Climate change [kg CO_2-equivalents]	Burdens	110.76	106.46
	CO_2 (reg)	11.37	13.28
	Credits	-14.68	-15.72
	CO_2 uptake	-37.49	-44.10
	Net results (∑)	69.96	59.92

3.1.2 Scenario II (100% allocation): numerical values and graphs

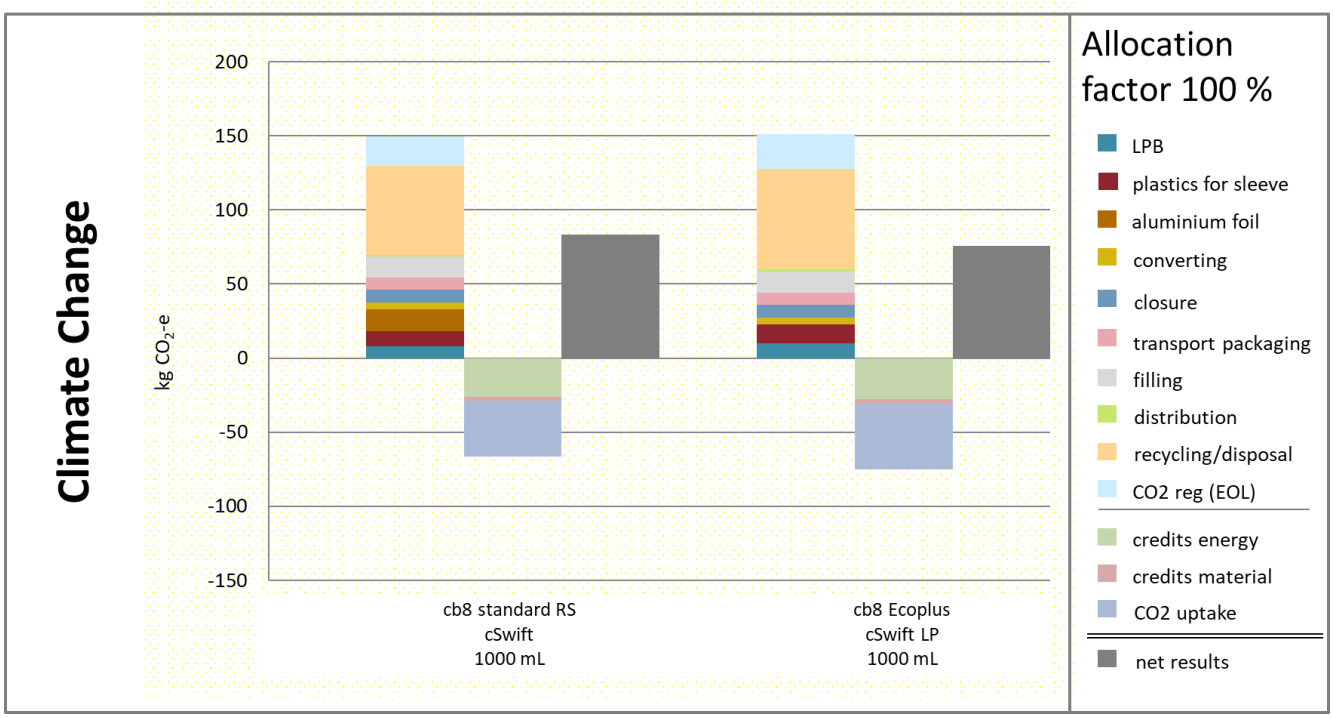

Figure 3-2: Climate Change results of **scenario II Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 100%

Table 3-2: Climate Change results of **scenario II Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 100%: burdens, credits and net results per functional unit of 1000 L beverage

Scenario II Poland, allocation factor 100 %		**cb8 standard RS cSwift 1000 mL**	**cb8 EcoPlus cSwift LP 1000 mL**
Climate change [kg CO_2-equivalents]	Burdens	129.56	127.52
	CO_2 (reg)	20.00	23.36
	Credits	-28.99	-30.99
	CO_2 uptake	-37.49	-44.10
	Net results (∑)	83.08	75.78

3.1.3 Comparison between systems

The percentages in **Table 3-6** show the difference of net results between all considered formats of combiblocMidi (cb8) beverage cartons in the same volume segment. The percentage is based on the net results of each compared packaging system. Both scenarios, scenario I (AF 50) and scenario II (AF 100), are equally used for the comparison between the systems. Differences of 10% or less are considered to be insignificant.

Table 3-3: Comparison of Climate Change net results of **combiblocMidi (cb8) beverage cartons** (Poland)

	The net results of	
	combiblocMidi (cb8) EcoPlus cSwift LP 1000 mL	
	are lower (green)/higher (red) than those of	
	combiblocMidi (cb8) standard RS cSwift 1000 mL	
	AF 50	**AF 100**
Impact category		
Climate Change	-14%	-9%

The beverage carton system combiblocMidi (cb8) EcoPlus cSwift LP (1000 mL) shows significantly lower 'Climate Change' impacts compared to the combiblocMidi (cb8) standard RS cSwift only in scenario I (AF 50). No significant difference to the combiblocMidi (cb8) standard RS cSwift is shown in scenario II (AF 100).

3.2 Poland combiblocMidi (cb8) beverage cartons 500 mL

3.2.1 Scenario I (50% allocation): numerical values and graphs

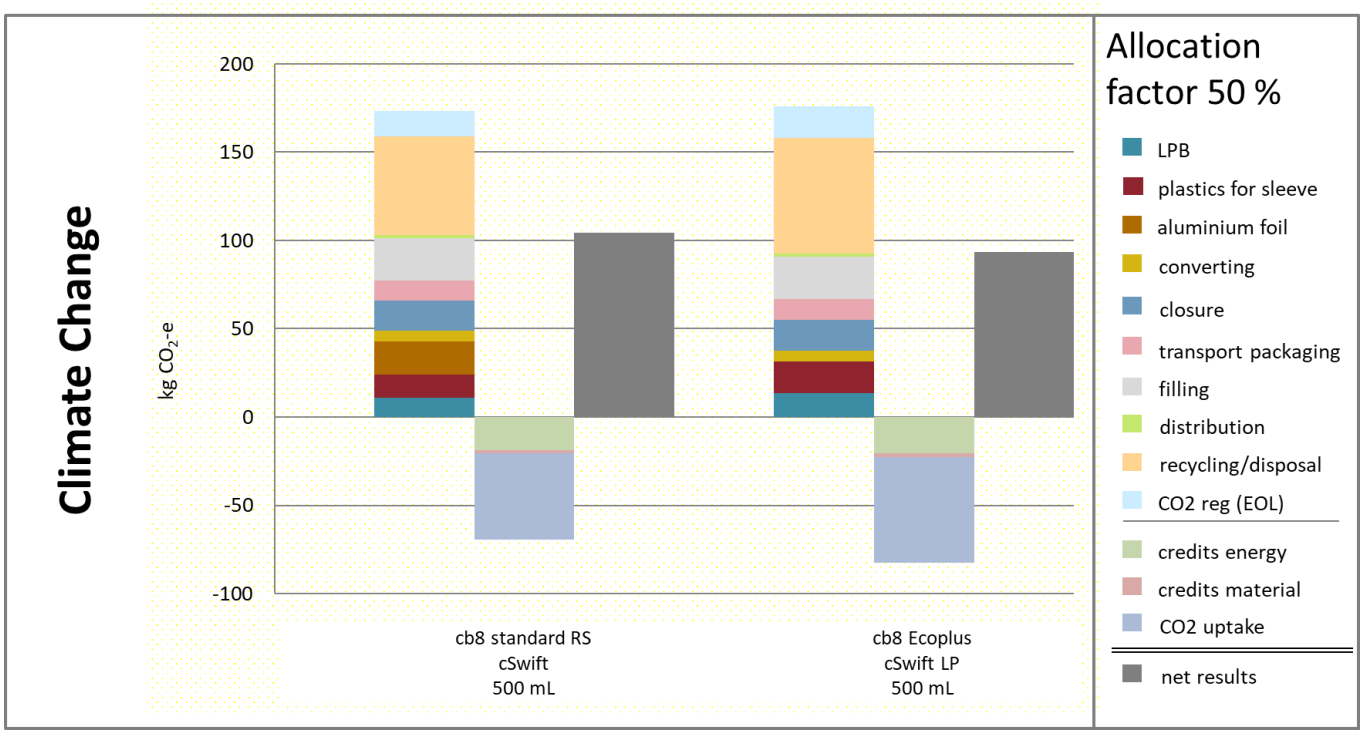

Figure 3-3: Climate Change results of **scenario I Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 50%

Table 3-4: Climate Change results of **scenario I Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 50%: burdens, credits and net results per functional unit of 1000 L beverage

Scenario I Poland, allocation factor 50 %		**cb8 standard RS cSwift 500 mL**	**cb8 Ecoplus cSwift LP 500 mL**
Climate Change [kg CO_2-equivalents]	Burdens	158.80	158.04
	CO_2 (reg)	14.73	17.88
	Credits	-20.57	-22.69
	CO_2 uptake	-48.78	-59.75
	Net results (∑)	104.18	93.48

3.2.2 Scenario II (100% allocation): numerical values and graphs

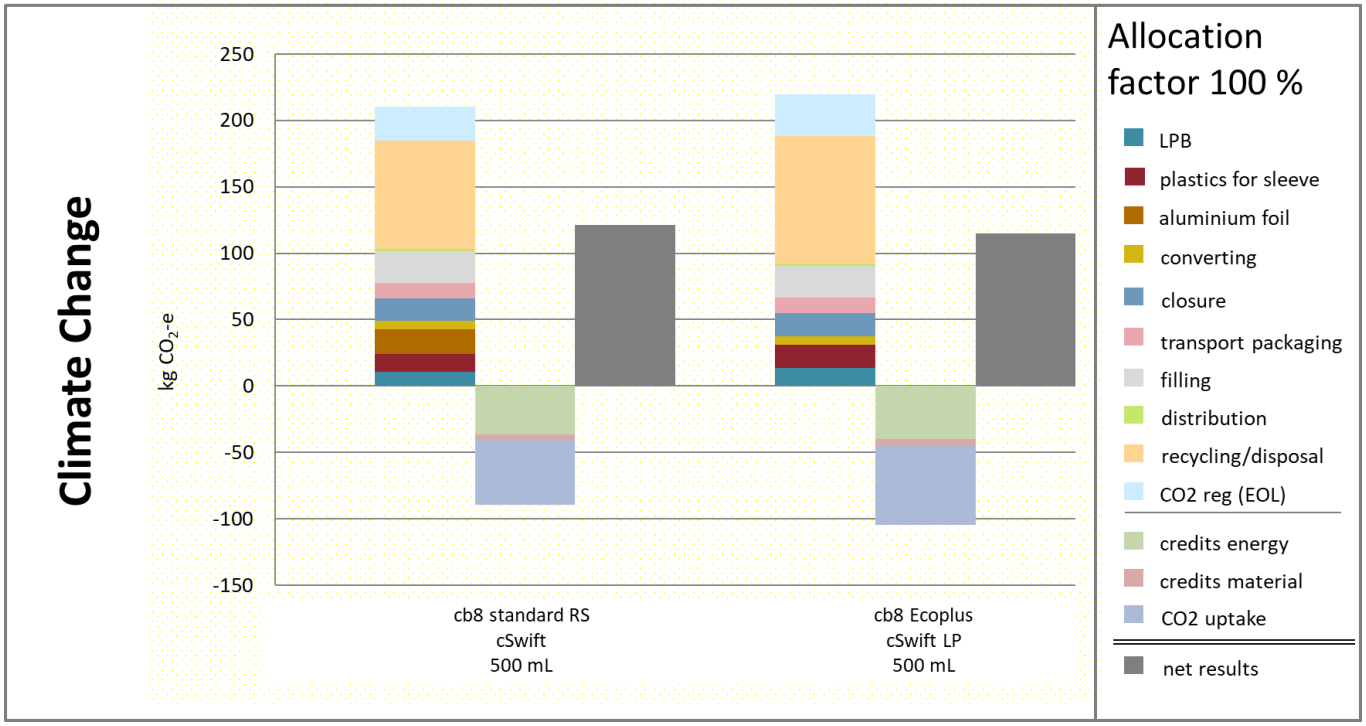

Figure 3-4: Climate Change results of **scenario II Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 100%

Table 3-5: Climate Change results of **scenario II Poland, combiblocMidi (cb8) beverage cartons** with allocation factor 100%: burdens, credits and net results per functional unit of 1000 L beverage

Scenario II Poland, allocation factor 100 %		cb8 standard RS cSwift 500 mL	cb8 Ecoplus cSwift LP 500 mL
Climate Change [kg CO_2-equivalents]	Burdens	184.79	188.10
	CO_2 (reg)	25.80	31.37
	Credits	-40.63	-44.78
	CO_2 uptake	-48.78	-59.75
	Net results (∑)	121.18	114.94

3.2.3 Comparison between systems

The percentages in **Table 3-6** show the difference of net results between all considered formats of combiblocMidi (cb8) beverage cartons in the same volume segment. The percentage is based on the net results of each compared packaging system. Both scenarios, scenario I (AF 50) and scenario II (AF 100), are equally used for the comparison between the systems. Differences of 10% or less are considered to be insignificant.

Table 3-6: Comparison of Climate Change net results of **combiblocMidi (cb8) beverage cartons** (Poland)

	The net results of	
	combiblocMidi (cb8) EcoPlus cSwift LP 500 mL	
	are lower (green)/higher (red) than those of	
	combiblocMidi (cb8) standard RS cSwift 500 mL	
	AF 50	**AF 100**
Impact category		
Climate Change	-10%	-5%

The combiblocMidi (cb8) EcoPlus cSwift LP (500 mL) shows no significant difference in 'Climate Change' in both scenarios (AF 50, AF 100) compared to the combiblocMidi (cb8) standard RS cSwift.

4 Conclusions and Recommendations

Conclusions

- The beverage carton system combiblocMidi (cb8) EcoPlus cSwift LP (1000 mL) shows significantly lower net results than the combiblocMidi (cb8) standard RS cSwift only in scenario l (AF 50). No significant difference to the combiblocMidi (cb8) standard RS cSwift is shown in scenario ll (AF 100).
- The combiblocMidi (cb8) EcoPlus cSwift LP (500 mL) shows no significant difference in 'Climate Change' in both scenarios (AF 50, AF 100) compared to the combiblocMidi (cb8) standard RS cSwift.
- The results in 'Climate Change' from Poland differ significantly from the results of the main report (Europe). They are higher than in Europe because the Polish electricity mix leads to higher emissions especially in the life cycle step 'filling' and the lower recycling and incineration rates lead to higher emissions from the end-of-life processes i.e. from landfills.
- To get an indication of how the packaging systems examined in this extension study perform in other environmental impact categories like 'Ozone Depletion', 'Summer Smog', 'Particulate Matter', 'Acidifi-cation', 'Terrestrial- and Aquatic Eutrophication', 'Abiotic Resource Depletion', 'Non-renewable Primary Energy' and 'Total Primary Energy', one can also refer to the main report regarding the European market. However, some background parameters are different due to the different geographical scopes. For this reason, the results of the European scope can only serve as an indication of the full set of environmental impact categories.

Recommendations

- Since the environmental result of the combiblocMidi (cb8) beverage carton format is significantly influenced by the production of its main components, the sleeve and closure, measures to ensure the same functionality by the use of less material are recommended.
- As the comparison shows no clear result for 'Climate Change' in both scenarios (AF 100 no significant difference), therefore no overall recommendations for one nor the other combiblocMidi (cb8) beverage carton (1000 mL) on the Polish market can be given.
- As the comparison shows no clear result for 'Climate Change' in both scenarios (AF 50 and AF 100 no significant difference), therefore no overall recommendations for one nor the other combiblocMidi (cb8) beverage carton (500 mL) on the Polish market can be given.
- It is shown in this extension that the closures can contribute a considerable amount to the overall life cycle impacts of beverage cartons. To improve the overall environmental performance it is recommended to assess the possibilities of using smaller and lighter closures for beverage cartons especially for beverage cartons with smaller volumes.

References

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