INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

Extension: Life Cycle Assessment of cb8/cf8 SIG beverage cartons on the Austrian market

Comparative life cycle assessment of *cb8/cf8 SIG beverage cartons* for liquid dairy and NCSD on the Austrian market

Final report

CB-100745

commissioned by SIG Combibloc

Heidelberg, April 2025

1 Introduction

The focus of this extension is to investigate cb8/cf8 SIG beverage cartons on the Austrian market. In this extension, the beverage cartons listed in **Table 1-1**, which were already examined in the main report (Analysis of *cb8/cf8 SIG beverage cartons* on the European market), are evaluated again, but with country-specific parameters for Austria (same material composition, same weight). The comparisons of the cb8/cf8 SIG beverage cartons are structured according to the same scheme.

Table 1-1: List of cb8/cf8 SIG beverage cartons examined for the Austrian market

Beverage carton with closure	Short name of beverage carton
SIG MidiBloc (cb8) Standard RS - 1000 ml with SIG SwiftCap Linked	cb8/cf8 standard RS - 1000 ml SwiftCap Linked
SIG MidiFit (cf8) Standard RS - 1000 ml with SIG SwiftCap Linked	
SIG Terra MidiBloc (cb8) Alu-free Full barrier - 1000 ml with SIG SwiftCap Linked LightProof	cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP
SIG Terra MidiFit (cf8) Alu-free Full barrier - 1000 ml with SIG SwiftCap Linked LightProof	
SIG Terra MidiBloc (cb8) Alu-free Full barrier Forest-based polymers - 1000 ml with SIG SwiftCap Linked LightProof	cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP
SIG Terra MidiFit (cf8) Alu-free Full barrier Forest-based polymers - 1000 ml with SIG SwiftCap Linked LightProof	

This extension focusses only on the 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.

This extension is conducted according to the requirements of ISO applicable standards [ISO 14040] and [ISO 14044]. This study is not critically reviewed. It should be noted though, that it is very similar to the main study for the European market and the country-specific extensions conducted by ifeu previously:

- Analysis of *cb8/cf8 SIG beverage cartons* on the European market [CB-100740]
- Life Cycle Assessment of cb8/cf8 SIG beverage cartons and alternative packaging systems on the German market [CB-100741]
- Life Cycle Assessment of cb8/cf8 SIG beverage cartons and alternative packaging systems on the French market [CB-100742]
- Life Cycle Assessment of cb8/cf8 SIG beverage cartons and alternative packaging systems on the Spanish market [CB-100743]

- Life Cycle Assessment of cb8/cf8 SIG beverage cartons and alternative packaging systems on the Italian market [CB-100744]

These studies have been critically reviewed and are full ISO compliancy confirmed by an independent review panel consisting of:

- Michael Sturges (chair; RISE Research Institutes of Sweden)
- Alex Hetherington (3keel Group Ltd, United Kingdom)
- Nicolas Cayé (GVM, Germany)

The only difference to these studies is the market examined. Apart from that, the goal and scope, as well as the applied methodology and the presentation of results remain the same.

2 Adjusted parameters

Adjusted parameters for the geographic scope of the extension are:

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

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

- Selection of packaging system
- Packaging specifications
- Life cycle inventory
- 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 processes

2.1 Packaging system

2.1.1 Packaging specifications

With this extension, the Climate Change impacts of the *cb8/cf8 SIG beverage cartons* shall be assessed on the Austrian market. The following **Table 2-1** presents the packaging specifications of the *cb8/cf8 SIG beverage cartons* as already outlined in the main report. Further relevant and adjusted settings and parameters are listed in the following sections.

Table 2-1: Packaging specifications of the examined *cb8/cf8 SIG beverage cartons* on the Austrian market

Specification	Unit	Packaging system		
		cb8/cf8 standard RS – 1000 ml SwiftCap Linked	***cb8/cf8 SIG Terra AFFB – 1000 ml SwiftCap Linked LP***	***cb8/cf8 SIG Terra AFFB + fbp – 1000 ml SwiftCap Linked LP***
volume	mL	1000	1000	1000
geographic scope	-	AT	AT	AT
primary packaging (sum)[1]	**g**	**29.52**	**32.03**	**32.03**
primary packaging (per FU)	**g/F**	**29520**	**32030**	**32030**
composite material (sleeve)	g	26.72	29.15	29.15
- liquid packaging board	g	20.278	23.661	23.661
- fossil PE	g	5.045	4.263	-
- mass-balanced PE	g	-	-	4.263
- aluminium foil	g	1.392	-	-
- barrier film (fossil-based)	g	-	1.227	-
- barrier film (mass-balanced)	g	-	-	1.227
closure	g	2.80	2.88	2.88
- fossil PP	g	1.54	1.58	-
- mass-balanced PP	g	-	-	1.58
- fossil PE	g	1.26	1.30	-
- mass-balanced PE	g	-	-	1.30
secondary packaging (sum)[2]	**g**	204	204	204
- tray/box (corrugated cardboard)	g	204	204	204
tertiary packaging (sum)[3]	**g**	**22350**	**22350**	**22350**
- Wooden pallet	g	22000	22000	22000
- type of pallet	-	EURO	EURO	EURO
number of use cycles	-	25	25	25
- cardboard layer (per pallet)	g	1750	1750	1750
- stretch film (per pallet) (LDPE)	g	350	350	350
pallet configuration				
prim. packaging per sec. packaging	pc	12	12	12
sec. packaging per layer	pc	13	13	13
layers per pallet	pc	5	5	5
prim. packaging per pallet	pc	780	780	780

[1] per primary packaging unit; [2] per secondary packaging unit; [3] per tertiary packaging unit (pallet)

[1] per primary packaging unit
[2] per secondary packaging unit
[3] per tertiary packaging unit (pallet)

2.2 Adjusted parameters

2.2.1 Transport distance

The following **Table 2-2** shows the transport distance applied for the Austrian market.

Table 2-2: Transport distance and means for the Austrian market: Transport defined by distance and mode (km/mode)

Austria	Transport distance
Packaging element	**Distance of converter to filler (km)**
Converted cartons	800 / road[4]

2.2.2 Distribution

Table 2-3 shows the applied distribution distance for the Austrian market. The distribution distance from filling to the point-of-sale (POS) for the Austrian market was determined by ifeu.

Table 2-3: Distribution distances in Austria for the examined packaging systems

	Distribution distance			
	Distribution Step 1		**Distribution step 2**	
Austria	**Filler → distribution centre** (delivery)	**Distribution centre → filler** (return trip)	**Distribution centre → POS** (delivery)	**POS → distribution centre** (return trip)
Beverage cartons	300 km	90 km	30 km	30 km

[4] ifeu assumption

2.2.3 End-of-life

To model the end-of-life of the examined packaging systems 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 examined packaging systems of the Austrian market. These data have 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 Austria are listed in **Table 2-4**. The recyclability of the *SIG Terra Alu-free Full barrier (AFFB) beverage carton* has been tested by SIG in several trials. No negative impact on the recyclability of these beverage cartons was observed. Thus, the same recycling rate is applied for all beverage carton systems studied.

Table 2-4: End-of-life split of packaging systems examined

Austria		Source
Recycling rate		
Beverage cartons	41.88%	EXTR:ACT 2025, data for 2022
Disposal split		
Landfill	5.52 %	(eurostat 2022)
Incineration	94.48 %	

The remaining part of the post-consumer packaging waste is modelled and calculated according to the average rates for landfilling and incineration (MSWI) on the Austrian market. The disposal split (100 %) is divided into landfilling 5.52 % and incineration 94.48 %. This disposal split is also applied for the final disposal of recycled materials undergoing another life cycle in a subsequent system.

2.2.4 Electricity mix

Modelling of electricity generation is particularly relevant for the production of base materials as well as for filling processes, 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 Austria is 173 g/kWh for the electricity mix used (reference year 2021) (Fehrenbach et al. 2016; IEA 2021), while the average EU electricity mix is 349 g/kWh. This means that the Austrian electricity mix is responsible for around 50 % lower greenhouse gas emissions than the European one.

2.2.5 Municipal waste incineration

The electrical and thermal efficiencies of the municipal solid waste incineration plants (MSWI) are shown in **Table 2-5**.

Table 2-5: Electrical and thermal efficiencies of the incineration plants for Austria

Geographic Scope	Electrical efficiency	Thermal efficiency	Reference period	Source
Austria	4.0%	24.0%	2017	(CEWEP 2018)

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 Austria cb8/cf8 SIG beverage cartons

3.1.1 Base scenarios with 50 % allocation: numerical values and graphs

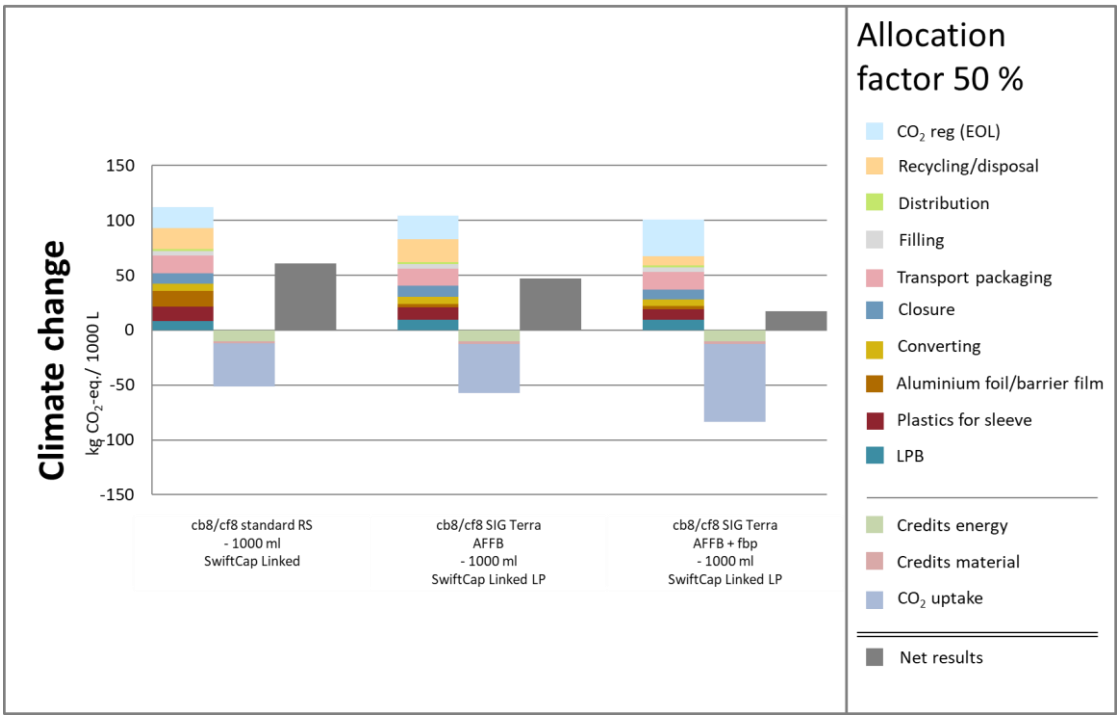

Figure 3-1: Climate Change results of examined packaging systems with allocation factor 50 %

Table 3-1: Climate Change results of allocation factor 50 %: burdens, credits and net results per functional unit of 1000 L beverage

Base scenarios: allocation factor 50 %		cb8/cf8 standard RS - 1000 ml SwiftCap Linked	cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP	cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP
Climate Change [kg CO_2-equivalents]	Burdens	93,02	82,87	67,13
	CO2 (reg)	18,75	21,35	33,60
	Credits	-12,11	-12,57	-12,57
	CO_2 uptake	-39,12	-44,58	-70,97
	Net results (∑)	60,53	47,06	17,18

3.1.2 Base scenarios with 100 % allocation: numerical values and graphs

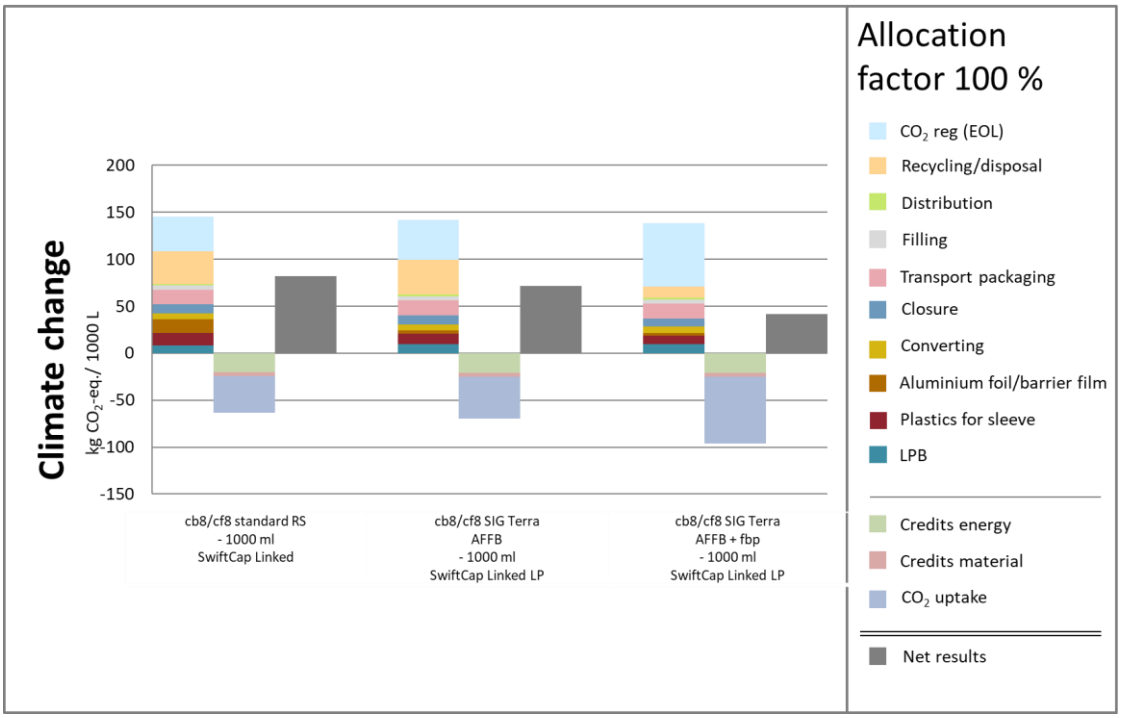

Figure 3-2: Climate Change results of examined packaging systems with allocation factor 100%

Table 3-2: Climate Change results of allocation factor 100 %: burdens, credits and net results per functional unit of 1000 L beverage

Base scenarios: allocation factor 100 %		cb8/cf8 standard RS - 1000 ml SwiftCap Linked	cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP	cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP
Climate Change [kg CO_2-equivalents]	Burdens	108,28	99,10	71,10
	CO2 (reg)	37,27	42,45	66,95
	Credits	-24,24	-25,16	-25,16
	CO_2 uptake	-39,12	-44,58	-70,97
	Net results (∑)	82,19	71,81	41,92

3.1.3 Description of results

The description of the cb8/cf8 SIG beverage cartons life cycle is shown in the main report in chapter ***4.3 Description and interpretation of base scenario results***.

3.1.4 Comparison between systems

The percentages in **Table 3-3** to **Table 3-5** show the net result comparison for the base scenarios with allocation factor 50 % and with allocation factor 100 %.

The colors green and blue illustrate the distinction between more (green) and less (blue[5]) favorable net results from the viewpoint of the packaging which is indicated in the respective table at the top and compared to the other packaging systems listed below. Percentages lower than 10 % are considered as insignificant differences and therefore marked by a grey shading of the respective fields.

The percentage is based on the net results of each packaging system. The base scenarios with allocation factor 50 % as well as with allocation factor 100 % are equally used for the comparison between the packaging systems.

Table 3-3: Comparison 1 of Climate Change net results of cb8/cf8 SIG beverage cartons (Austria)

	The net results of the base scenario of	
	cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP	
	are lower (green)/higher (blue) than those of the base scenario for	
	cb8/cf8 standard RS - 1000 ml SwiftCap Linked	
	AF 50	**AF 100**
Climate Change	-22%	-13%

In both base scenarios, the *cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP* shows lower net results than the *cb8/cf8 standard RS - 1000 ml SwiftCap Linked* in the impact category 'Climate Change'.

[5] Note that this does not apply to any of the categories shown in Table 3-3 to Table 3-5, as the corresponding comparison does not show less favourable results.

Table 3-4: Comparison 2 of Climate Change net results of cb8/cf8 SIG beverage cartons (Austria)

	The net results of the base scenario of **cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP** are lower (green)/higher (blue) than those of the base scenario for cb8/cf8 standard RS - 1000 ml SwiftCap Linked	
	AF 50	**AF 100**
Climate Change	-72%	-49%

In both base scenarios, the *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* shows lower net results than the *cb8/cf8 standard RS - 1000 ml SwiftCap Linked* in the impact category 'Climate Change'.

Table 3-5: Comparison 3 of Climate Change net results of cb8/cf8 SIG beverage cartons (Austria)

	The net results of the base scenario of **cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP** are lower (green)/higher (blue) than those of the base scenario for cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP	
	AF 50	**AF 100**
Climate Change	-63%	-42%

In both base scenarios, the *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* shows lower net results than the *cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP* in the impact category 'Climate change'.

4 Conclusions and Recommendations

4.1 Conclusions

4.1.1 Comparison of cb8/cf8 SIG beverage cartons

- The *cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP* shows lower net results in the 'Climate Change' category than the compared *cb8/cf8 standard RS - 1000 ml SwiftCap Linked* in both base scenarios (AF 50, AF 100). For this category and the comparison of cb8*/cf8* packaging systems, the results for Austria show a similar picture as those of the European market.
- The *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* shows lower net results in the 'Climate Change' category than the compared *cb8/cf8 standard RS - 1000 ml SwiftCap Linked* in both base scenarios (AF 50, AF 100). For this category and the comparison of cb8*/cf8* packaging systems, the results for Austria show a similar picture as those of the European market.
- The *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* shows lower net results in the 'Climate Change' category than the compared *cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP* in both base scenarios (AF 50, AF 100). For this category and the comparison of cb8*/cf8* packaging systems, the results for Austria show a similar picture as those of the European market.

4.2 Recommendations

- Since the Climate Change result of the *cb8/cf8 SIG beverage carton* format is significantly influenced by the production of its main components, the sleeve and closure, measures to use less material are recommended as long as the same functionality is ensured.
- It is further shown, that the alternative barrier film used for the *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* and the *cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP* has lower impacts in 'Climate Change' than the aluminium foil used in the *cb8/cf8 standard RS -1000 ml SwiftCap Linked beverage cartons.* In view of this and the fact that the use of the alternative barrier film has no negative influence on the recyclability of the beverage cartons after use, it is therefore recommended, that aluminium foils are substituted by alternative barrier films.
- The beverage cartons *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* (1000 mL) show the lowest environmental impacts in 'Climate Change'. Therefore, with a focus on climate change mitigation, it is recommended to prefer the *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* (1000 mL) over the other beverage carton formats examined in this study on the Austrian market.
- The *cb8/cf8 SIG Terra AFFB + fbp - 1000 ml SwiftCap Linked LP* having lower impacts than *cb8/cf8 SIG Terra AFFB - 1000 ml SwiftCap Linked LP* (which has the same specifications apart from the choice of polymers) shows that advantages in terms of Climate Change results can be reached by the use of mass-balanced renewable material. Consequently, the use of mass-balanced renewable material is recommended for Climate Change mitigation. In the authors' view, showing the benefits of using renewable materials by the application of the mass-balanced approach in the production of polymers, is

an important driver to facilitate an increasing substitution of fossil resources by biogenic resources for the production of polymers.

- It is also recommended to actually achieve a more significant physical share of tall oil-based input materials for the production of polymers, as the by-product of the pulp industry is currently mainly dedicated to direct thermal use. The utilisation and demand of mass-balanced polymers by SIG Combibloc might be a driver to do so.
- As this extension only includes results for the impact category Climate Change, it is recommended to consult the European main study (Analysis of *cb8/cf8 SIG beverage cartons* on the European market) in order to get an indication on how results of other impact categories may look like for similar packaging systems. The knowledge and understanding of the European study regarding the other impact categories is necessary to understand the broad environmental relevance of the examined packaging systems. It is important though, to keep in mind that the different geographic parameters also have a major impact on the results.

References

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