Life cycle assessment of various PET packaging units and alternative materials

Conference: Myths, facts and the future of food packaging

Prague, 2021, March 18th

Roland Fehringer, Version 1.0

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Core competences of c7, founded in 2017

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SUSTAINABLE PERFORMANCE

carbon | climate | change | communication | corporate social responsibility | cycle | certificate

- **Assessment of environmental impacts** of products and services: Life cycle analysis (LCA), Product Carbon Footprint, Water Footprint, Cost-Benefit-Analysis, Greenhouse gas inventory, CDP, Science Based Targets
- **Sustainability reporting**, GRI Standards, strategy, development of KPI's, Sustainable supply chain, sustainable sourcing
- **Environmental data management**, implementation of data management, indicators, development of KPI's
- **Resources and waste management** and substance flow analysis
- **Certificate** for the **Austrian & European Ecolabel**
- Implementation of **management systems** in cooperation with partners

Selected reference customers - since 2017

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ALPLA
Constantia Flexibles
greiner HOLDING AG
storaenso
vetropack
GETRÄNKE KARTON AUSTRIA
ARA Altstoff Recycling Austria
austria glasrecycling
PET RECYCLING TEAM A Member of the ALPLA Group
Starlinger viscotec foodgrade without compromise
VÖSLAUER
Ottakringer
TECNARO GESELLSCHAFT ZUR INDUSTRIELLEN ANWENDUNG NACHWACHSENDER ROHSTOFFE mbH
COLOP
ÖBB Infrastruktur
UHU
Sitex Textile Dienstleistungen
SALESIANER MIETTEX
bellaflora DIE WELT DER GRÜNEN NUMMER 1
Löffler
Niemetz SCHWEDENBOMBEN
ERBER Group
bene
BKS Bank
WKO ARGE Nachhaltigkeitsagenda der Österreichischen Getränkewirtschaft
VOSSEN A TOUCH OF ENERGY
doka
so geht sauber. hollu
KC KUNSTSTOFF CLUSTER
plus eco cluster niederösterreich
EFRE Europäische Union Investitionen in Wachstum & Beschäftigung. Österreich.
OMV

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LCA
packaging for beverage and food

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MEMBER OF TEAM ZF

Aim of the analysis

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- In a nutshell, the public perception of beverage packaging is as follows:
  - Plastic bottles and aluminium cans have a negative and glass bottles a positive environmental image.
- 2018 c7-consult was conducted by ALPLA to calculate a **life cycle assessment** in line with ISO 14044 for **brand name product packaging** made of PET and alternative packaging materials for certain beverages, foods and liquid detergents which are consumed via the food retail sector in twelve countries worldwide.
- ALPLA's purpose for the study was to promote an **objective discussion** of the environmental evaluation of the packaging examined on the basis of the latest set of data – **all packaging parts were weighted by c7**.
- The results were confirmed by two independent **reviewer** and published in parts in 2018.

Example for photo protocol: nutella is not part of the presented LCA!

Scope of the study

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- The entire study comprised 59 material-content combinations for **brand name products** typically found in Austria. Packaging mass of brand name products is similar all over the world!

Content	capacity [l]	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	HDPE OW	rHDPE 50% OW	rHDPE 100% OW	PP OW	Pouch OW	glass OW	glass MW	Alu-can OW	Fe-can OW	carton OW	
water	1,0	x	x	x	x	x	x						x	x				8
milk	1,0	x	x	x				x	x	x			x	x			x	9
juice	1,0	x	x	x									x	x			x	6
beer	0,5	x	x	x									x	x	x			6
CSD	0,5	x	x	x	x	x	x						x	x	x			9
food	0,35	x	x	x									x			x		5
ketchup	0,30	x	x	x				x	x	x	x		x					8
detergents	1,5	x	x	x				x	x	x	x	x						8
		8	8	8	2	2	2	3	3	3	2	1	7	5	2	1	2	59

- The study as a whole comprises 7 impact categories and 6 life cycle inventory analysis parameters.
- **Country specific data** are used for electricity mix, distances from bottler to retailer, waste management conditions like separate collection and recycling rates.
- In addition **continent specific data** are used for raw materials.

Beverage packaging

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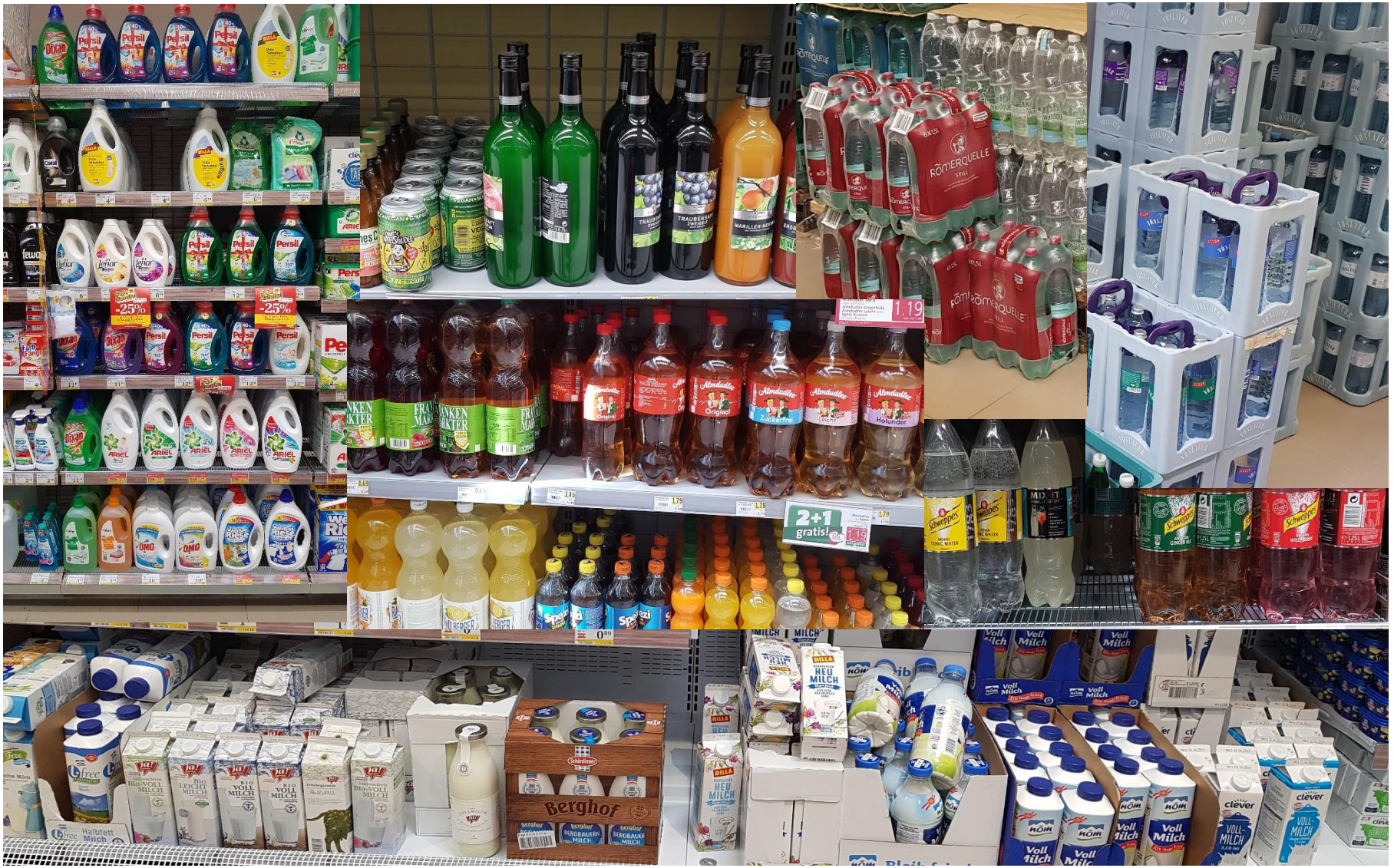

What is an LCA?
LCA – life cycle assessment

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- An LCA assesses the environmental impacts of products or services during their total life-cycle.
  - Production phase
    - Production of all materials starting from mine, well, forest or field
    - Production of intermediate products and products
    - Production of packaging materials
    - Supply of electricity, heat and fuels
  - Use phase
    - Consumption of electricity, fuels and other energy carriers
    - Distribution to warehouse and retailer
  - End of Life phase
    - Recycling - benefits because of substituted primary production
    - thermal treatment in cement kilns or municipal solid waste incineration plants
    - landfill

Procedure

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1. Definition of functional unit and system boundaries in time and space
   - Supply of 0,5 l beer in PET, glass, aluminium cans at Czech retailers in 2020 including recycling of single use bottles and washing of returnable bottles
2. Data collection:
   - Materials, recycling content and mass of beverage packaging
   - Production of packaging: container or bottles, caps, lids
   - Supply of energy (electricity mix Czech Republic), fuels and other energy carrier like natural gas
   - Transport distances, distribution to warehouse and retailer
   - Separate collection and recycling rates, thermal treatment
3. Transformation from physical units [kg, l, km, kWh, …] into life cycle data – environmental impacts
4. Balance of total life cycle
5. Conclusions, interpretation of results

Functional unit for todays presentation

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- Functional unit filling volumes
  - 1 litre of mineral water and milk
  - 0.5 litre of beer and carbonated soft drink (CSD)
  - 0.35 l of food jar
  - 0.3 l ketchup
- The product system comprises:
  - **Packaging unit**, closure and label
  - Sales packaging (carton tray, reusable crate, film)
  - Transport packaging (pallets, shrink wrap)
  - Packaging for delivery of packaging units, lids, etc. to the bottler
- The analysis covers the packaging units' **entire life cycle**:
  - Production of raw materials and generation of electricity
  - Packaging manufacturing
  - Filling and maybe cleaning of reusable packaging units
  - Distribution from the bottler to the food retailers
  - Collection, recycling and disposal of the primary packaging, sales packaging and transport packaging
  - Other transports: raw materials, packaging to bottler, waste to recycling

Environmental impacts

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- Climate change or Carbon Footprint [kg CO_2-eq.]
  - The impact category climate change addresses the direct and indirect impact of anthropogenic cause warming of our atmosphere. The greenhouse gas effect is the physical basis.
  - Most important greenhouse gases are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (laughing gas) (N_2O), ozone (O_3), halogenated hydrocarbons (e.g. CFC's) and water vapour (H_2O).
- Acidification [kg SO_2-eq.]
  - The impact category acidification addresses the reduction of the pH-value or the decline in aquatic and terrestrial systems. A reduction of the pH-value can destroy the ecological balance of ecosystems. The phenomena is also known as „forest decline".
  - Most important emissions for acidification are nitrogen oxides (NO_x), sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and hydrochloric acid (HCl).

Environmental impacts and life cycle inventory

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- Photochemical oxidation (summer smog) [kg Ethylene-Äqu.]
  - Heavy solar irradiation results under involvement of hydrocarbons and nitrogen oxides to higher concentrations of ozone and other photooxidants. Nitrogen oxides from incineration processes especially from trucks near the ground are responsible for the ozone formation.
  - Most important emissions for summer smog are : volatile organic carbons (NMVOC and VOC), benzol, methane (CH_4), acetylene, ethanol, formaldehyde and others.
- Water consumption [Litre]
  - During the oil production water is polluted, in mines water is used to reduce the dust emissions, cardboard production needs a lot of water, forests need water to grow.
  - Many processes need cooling water
  - Water is also used to wash multiple way beverage packaging bottles, or for washing the waste before recycling

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Input data & results

mineral water, milk, beer, CSD
food jar & ketchup

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Input data - mineral water

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water 1,0 l	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW
volume	[ml]	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
cycles	[-]	1	1	1	20	20	20	1	30
mass of container	[g]	24,9	24,9	24,9	65,0	65,0	65,0	470,0	551,9
material cap	[-]	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	Tinplate	Alu
mass cap	[g]	3,00	3,00	3,00	3,00	3,00	3,00	2,20	1,70
material label	[-]	PET	PET	PET	paper	paper	paper	paper	paper
mass label	[g]	0,35	0,35	0,35	1,00	1,00	1,00	1,00	1,00
mass product system: container, cap & label	[g]	28,26	28,26	28,26	69,00	69,00	69,00	473,20	554,58

secondary packaging / sales packaging	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW
container per tray/box	[pieces]	4	4	4	9	9	9	12	12
mass materials single use	[g]	12,16	12,16	12,16	0,26	0,26	0,26	-	-
mass materials multiple use	[g]	-	-	-	1.750,00	1.750,00	1.750,00	2.500,00	1.750,00

tertiary packaging / transport packaging per palette	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW
container per palette	[pieces]	576	576	576	396	396	396	384	384
mass materials single use	[g]	5.001	5.001	5.001	101	101	101	-	-
mass materials multiple use	[g]	24.000	24.000	24.000	25.750	25.750	25.750	26.500	25.750

delivery to stores	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW
mass for transport total	[kg]	22.429	22.429	22.429	18.880	18.880	18.880	17.412	16.247
delivery step 1 outbound	[km]	200	200	200	200	200	200	200	200
delivery step 1 inbound	[km]	60	60	60	200	200	200	60	200
delivery step 2 outbound	[km]	50	50	50	50	50	50	50	50
delivery step 2 inbound	[km]	50	50	50	50	50	50	50	50
delivery total	[km]	360	360	360	500	500	500	360	500
cooling lorry needed (1 = yes)	[-]	0	0	0	0	0	0	0	0

waste management	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW
allocation benefit recycling	[%]	50%	50%	50%	50%	50%	50%	50%	50%

Results – mineral water
Climate change

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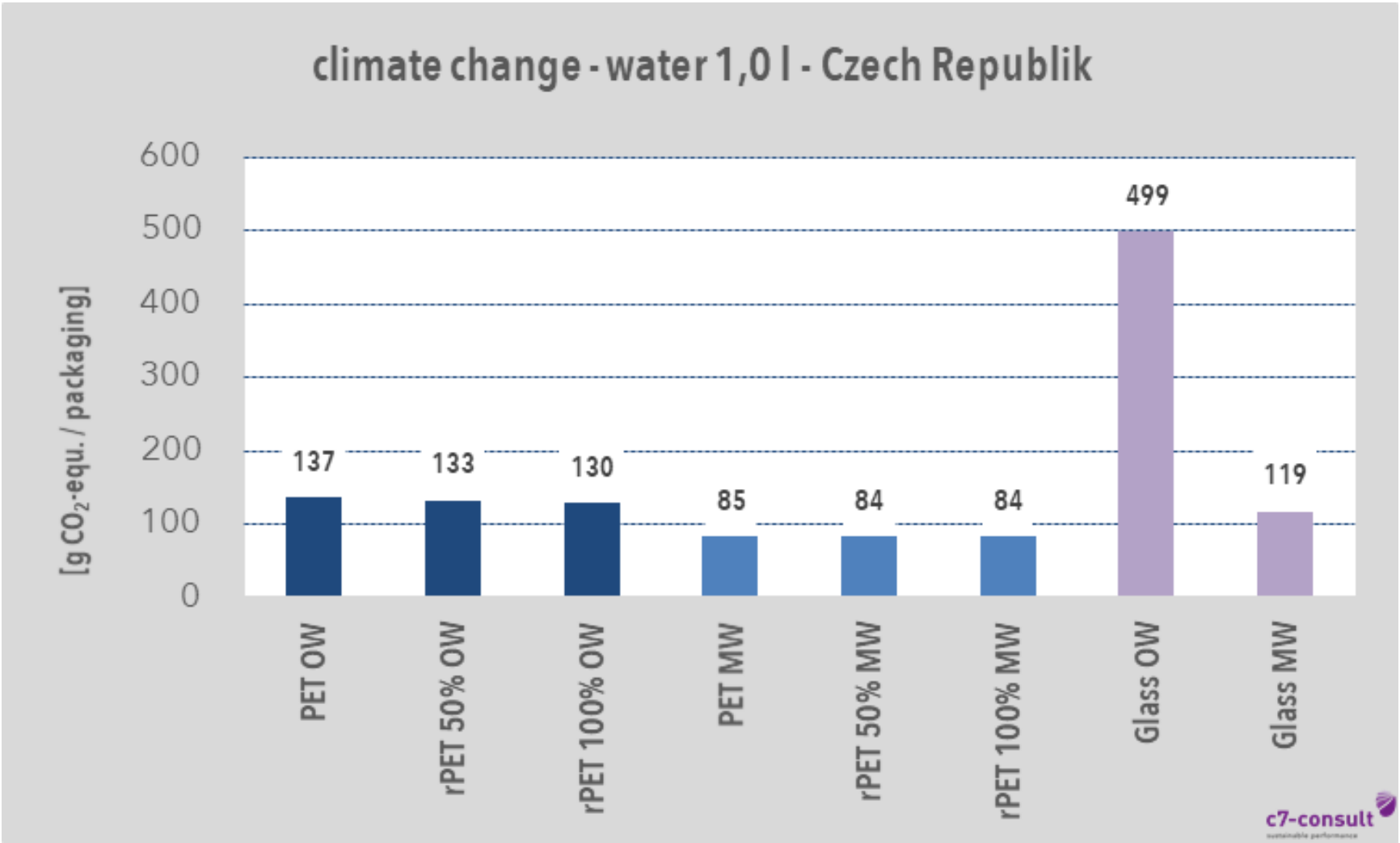

Results – mineral water
Climate change - details

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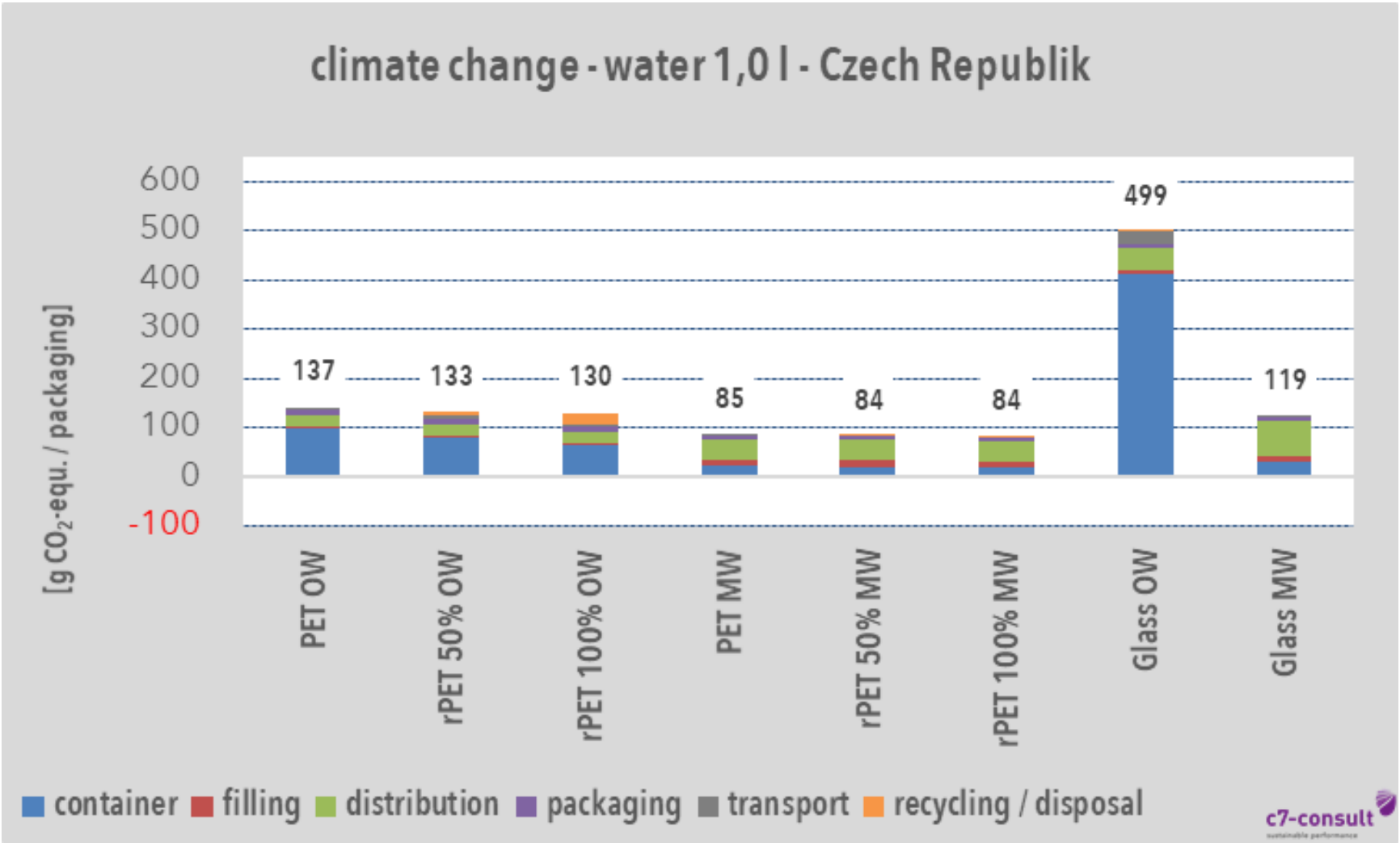

Results – mineral water
Climate change possible improvements

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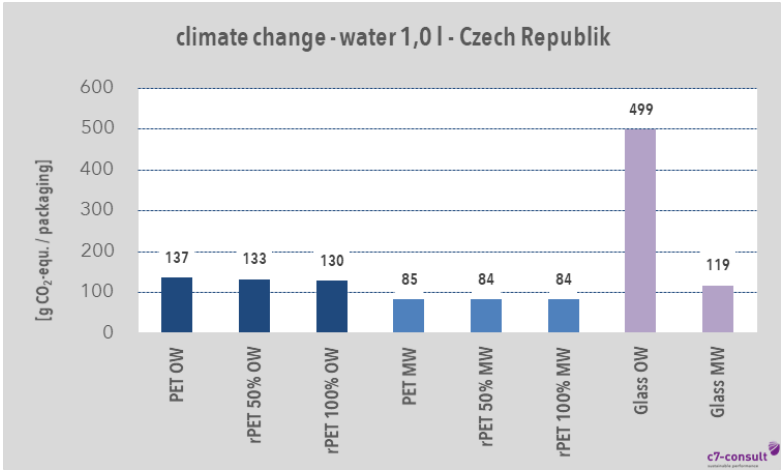
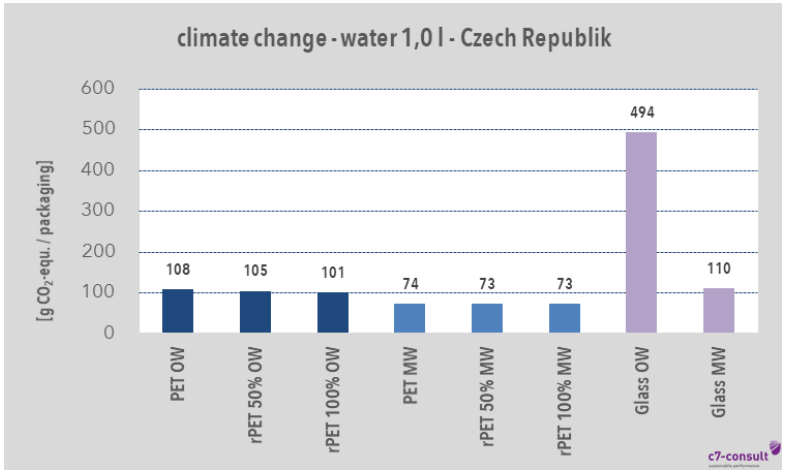
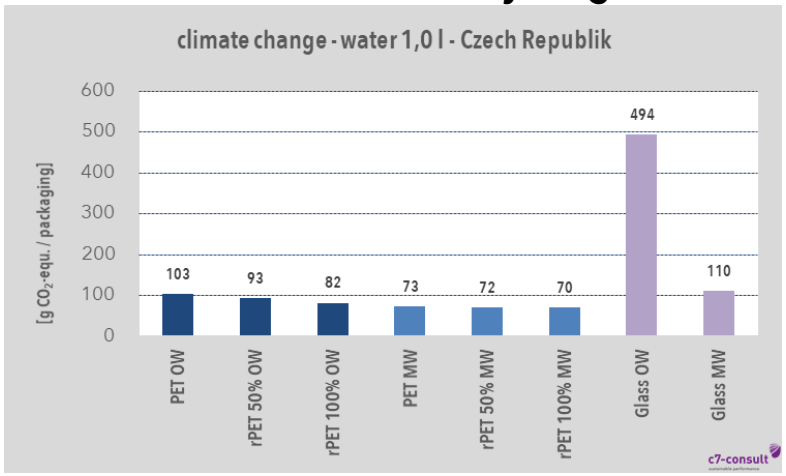
basis calculation



with electricity from renewable sources



with electricity from renewable sources & rPET from ALPLA's PET Recycling TEAM



Results – mineral water
Acidification & Photochemical oxidation (summer smog)

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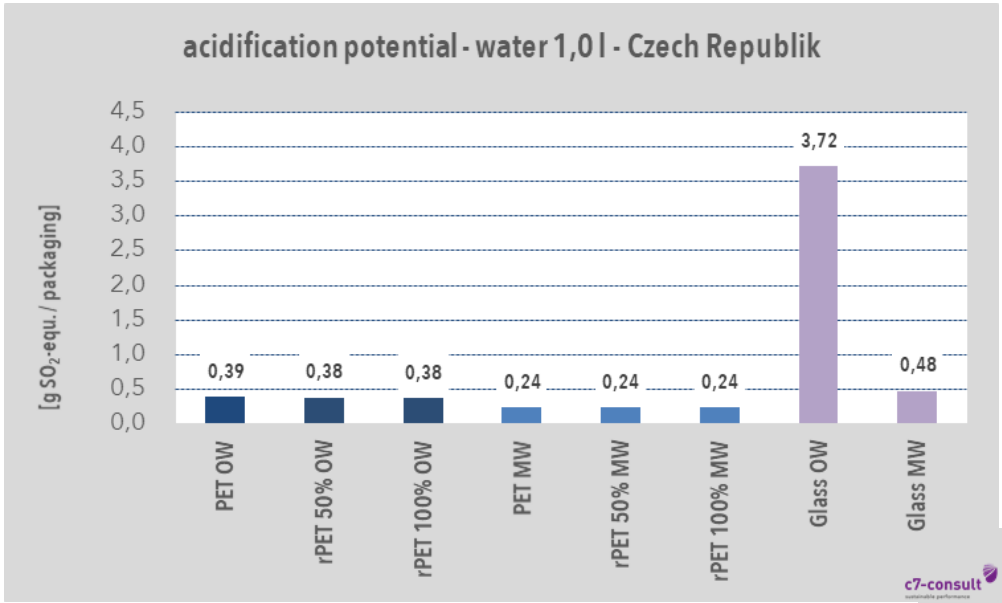

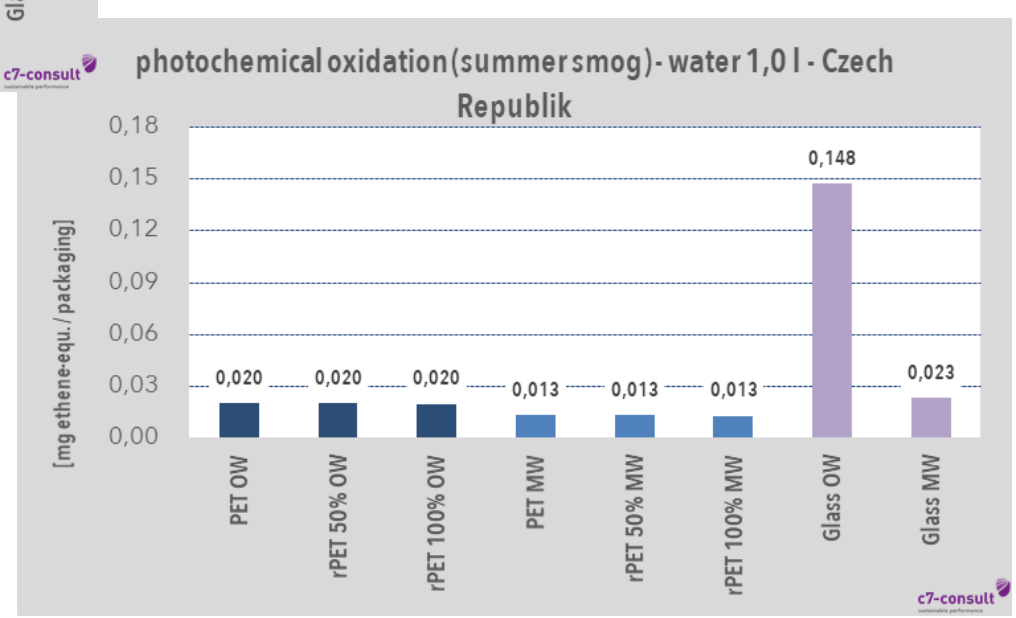

Results – mineral water
Myth: number of cycles more than 30 or 50

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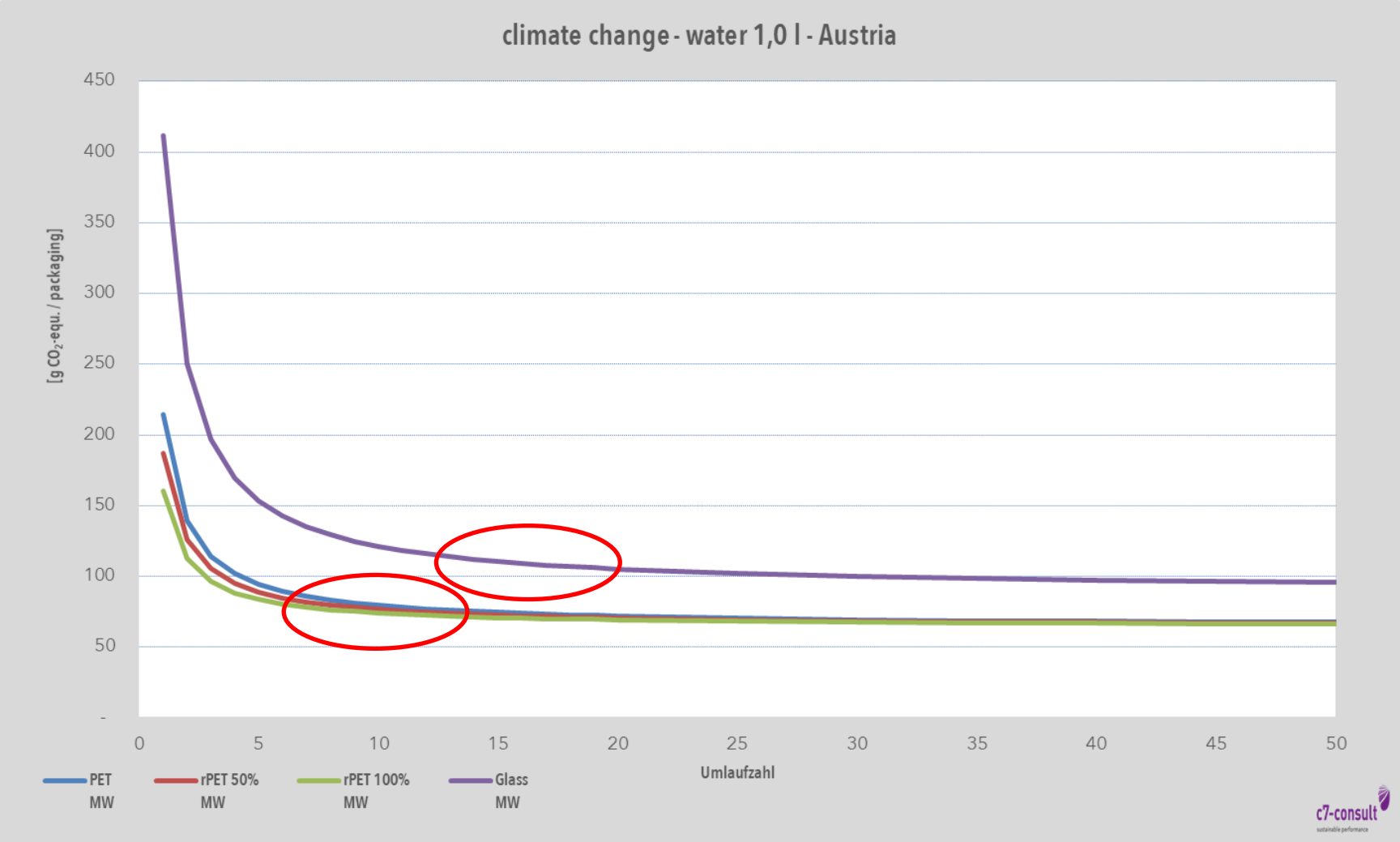

Input data - milk

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milk 1,0 l	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	Glass OW	Glass MW	Carton
volume	[ml]	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
cycles	[-]	1	1	1	1	1	1	1	15	1
mass of container	[g]	22,10	22,10	22,10	18,80	18,80	18,80	420,00	493,17	25,00
material cap	[-]	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	Tinplate	Tinplate	HDPE
mass cap	[g]	2,67	2,67	2,67	1,65	1,65	1,65	4,02	4,02	8,00
material label	[-]	PET	PET	PET	paper	paper	paper	paper	paper	no label
mass label	[g]	3,16	3,16	3,16	1,50	1,50	1,50	1,78	1,78	-
mass product system: container, cap & label	[g]	27,93	27,93	27,93	21,95	21,95	21,95	425,80	498,97	33,00

secondary packaging / sales packaging	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	Glass OW	Glass MW	Carton
container per tray/box	[pieces]	12	12	12	12	12	12	6	6	12
mass materials single use	[g]	150,28	150,28	150,28	140,20	140,20	140,20	165,20	0,20	122,20
mass materials multiple use	[g]	-	-	-	-	-	-	-	1.200,00	-

tertiary packaging / transport packaging per palette	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	Glass OW	Glass MW	Carton
container per palette	[pieces]	864	864	864	864	864	864	408	306	624
mass materials single use	[g]	2.967	2.967	2.967	3.352	3.352	3.352	172	172	172
mass materials multiple use	[g]	24.000	24.000	24.000	24.000	24.000	24.000	24.000	25.200	24.000

delivery to stores	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	Glass OW	Glass MW	Carton
mass for transport total	[kg]	24.074	24.074	24.074	23.931	23.931	23.931	20.365	17.954	22.279
delivery step 1 outbound	[km]	150	150	150	150	150	150	150	150	150
delivery step 1 inbound	[km]	150	150	150	150	150	150	150	150	150
delivery step 2 outbound	[km]	50	50	50	50	50	50	50	50	50
delivery step 2 inbound	[km]	50	50	50	50	50	50	50	50	50
delivery total	[km]	400	400	400	400	400	400	400	400	400
cooling lorry needed (1 = yes)	[-]	1	1	1	1	1	1	1	1	1

waste management	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	Glass OW	Glass MW	Carton
allocation benefit recycling	[%]	50%	50%	50%	50%	50%	50%	50%	50%	50%

Results – milk

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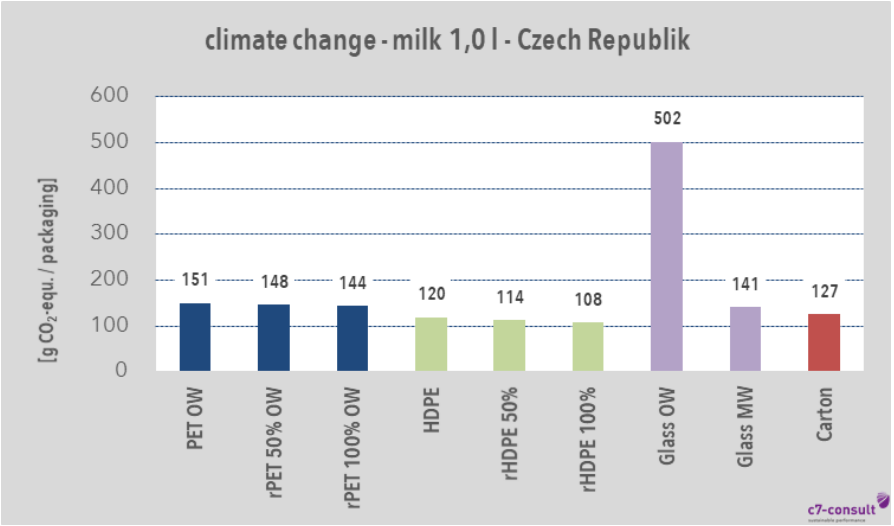

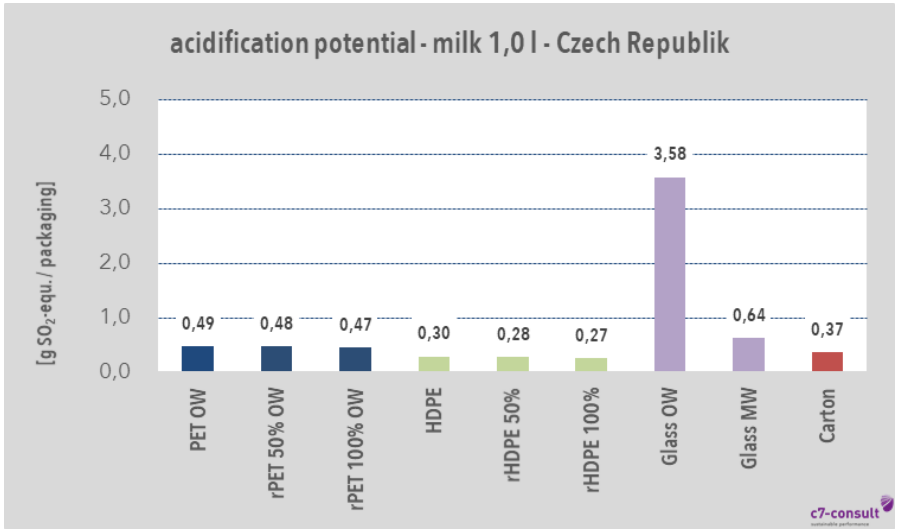

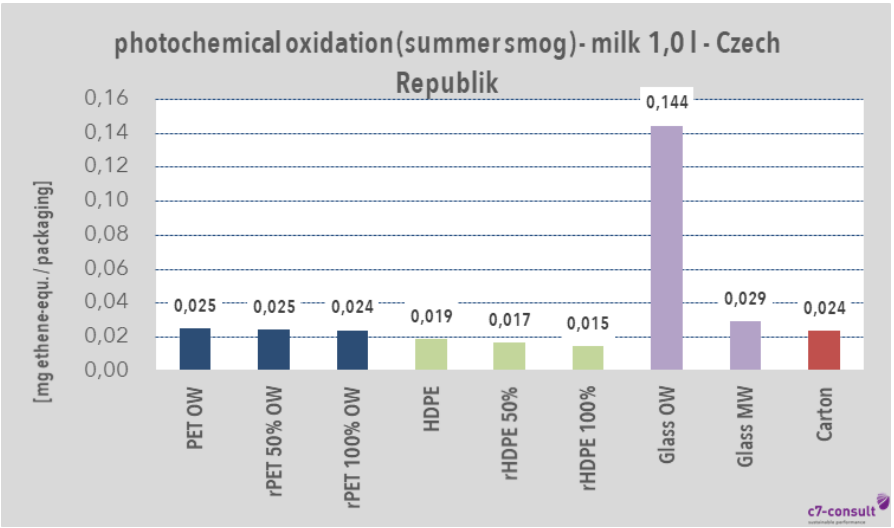

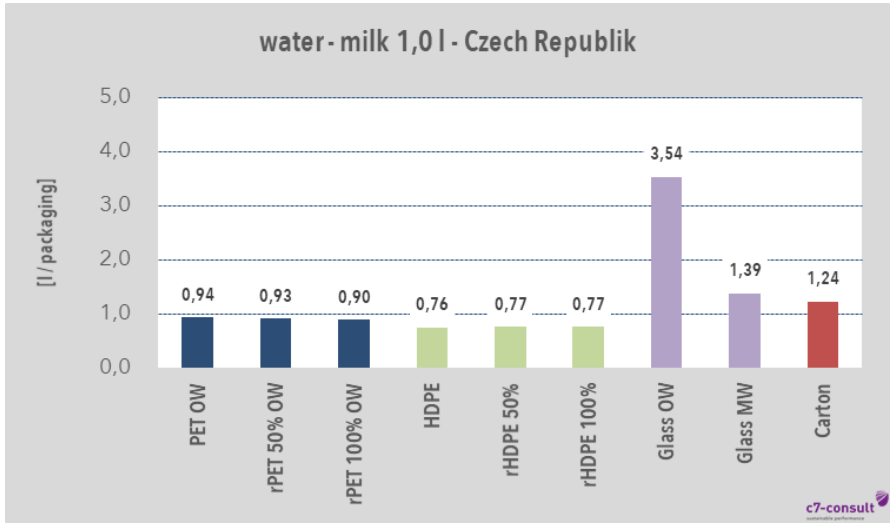

Input data - beer

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beer 0,5 l	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	Glass MW	ALU can
volume	[ml]	500	500	500	500	500	500
cycles	[-]	1	1	1	1	30	1
mass of container	[g]	31,2	31,2	31,2	278,0	374,0	12,80
material cap	[-]	HDPE	HDPE	HDPE	Tinplate	Tinplate	Alu
mass cap	[g]	2,30	2,30	2,30	2,20	2,20	2,50
material label	[-]	paper	paper	paper	paper	paper	no label
mass label	[g]	1,50	1,50	1,50	1,50	1,50	-
mass product system: container, cap & label	[g]	35,00	35,00	35,00	281,70	377,70	15,30

secondary packaging / sales packaging	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	Glass MW	ALU can
container per tray/box	[pieces]	18	18	18	24	20	24
mass materials single use	[g]	20,50	20,50	20,50	340,42	-	106,28
mass materials multiple use	[g]	-	-	-	-	1.860	-

tertiary packaging / transport packaging per palette	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	Glass MW	ALU can
trays/boxes per layer	[pieces]	12	12	12	9	10	12
layer per palette	[pieces]	6	6	6	5	4	6
container per palette	[pieces]	1.296	1.296	1.296	1.080	800	1.728

delivery to retailer	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	Glass MW	ALU can
mass for transport total	[kg]	18.779	18.779	18.779	23.049	20.815	24.064
container per lorry	[pieces]	33.696	33.696	33.696	28.080	20.800	44.928
delivery step 1 outbound	[km]	200	200	200	200	200	200
delivery step 1 inbound	[km]	40	40	40	40	200	40
delivery step 2 outbound	[km]	50	50	50	50	50	50
delivery step 2 inbound	[km]	50	50	50	50	50	50
delivery total	[km]	340	340	340	340	500	340
cooling lorry needed (1 = yes)	[-]	0	0	0	0	0	0

waste management	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	Glass MW	ALU can
allocation benefit recycling	[%]	50%	50%	50%	50%	50%	50%

Results – beer

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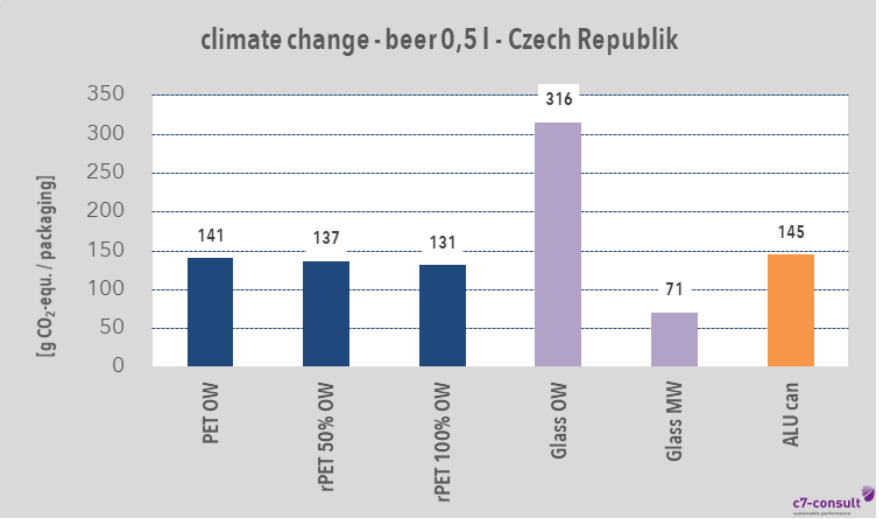

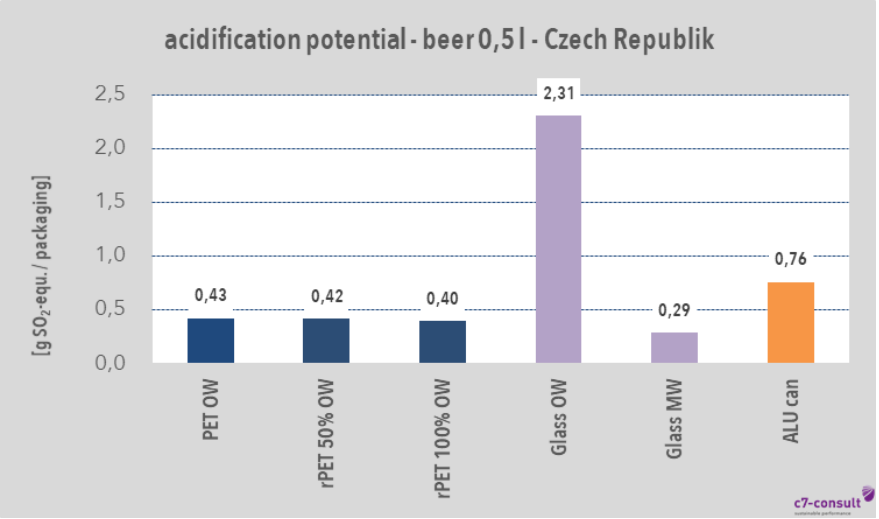

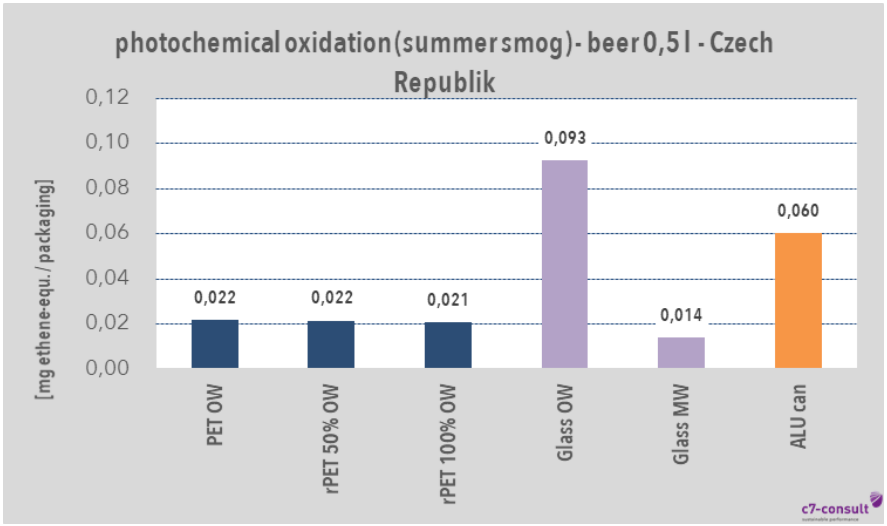

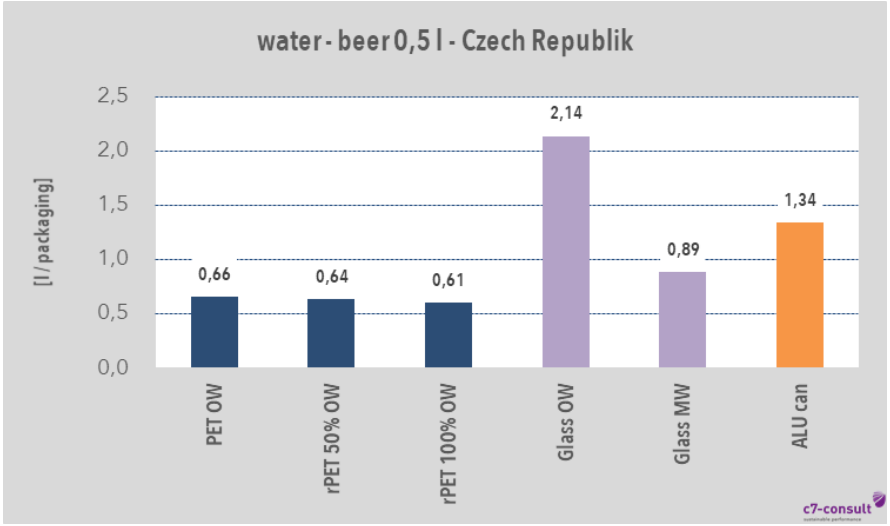

Input data – CSD / carbonated soft drinks

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CSD 0,5 l	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW	ALU can
volume	[ml]	500	500	500	500	500	500	500	500	500
cycles	[-]	1	1	1	20	20	20	1	30	1
mass of container	[g]	20,76	20,76	20,76	50,00	50,00	50,00	335,00	385,00	12,80
material cap	[-]	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	Alu	Alu	Alu
mass cap	[g]	2,18	2,18	2,18	3,00	3,00	3,00	1,50	1,50	2,65
material label	[-]	PP	PP	PP	PET	PET	PET	paper	paper	no label
mass label	[g]	0,28	0,28	0,28	0,30	0,30	0,30	1,50	1,50	-
mass product system: container, cap & label	[g]	23,22	23,22	23,22	53,30	53,30	53,30	338,00	388,00	15,45

secondary packaging / sales packaging	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW	ALU can
container per tray/box	[pieces]	12	12	12	12	12	12	6	20	24
mass materials single use	[g]	8,85	8,85	8,85	-	-	-	169,15	-	105,50
mass materials multiple use	[g]	-	-	-	1.750,00	1.750,00	1.750,00	-	2.000,00	-

tertiary packaging / transport packaging per palette	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW	ALU can
container per palette	[pieces]	1.296	1.296	1.296	840	840	840	864	800	1.728
mass materials single use	[g]	3.451	3.451	3.451	1	1	1	3.451	1	3.451
mass materials multiple use	[g]	24.000	24.000	24.000	25.750	25.750	25.750	24.000	26.000	24.000

delivery to stores	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW	ALU can
mass for transport total	[kg]	18.369	18.369	18.369	15.893	15.893	15.893	20.172	21.174	24.069
delivery step 1 outbound	[km]	250	250	250	250	250	250	250	250	250
delivery step 1 inbound	[km]	50	50	50	250	250	250	50	250	50
delivery step 2 outbound	[km]	50	50	50	50	50	50	50	50	50
delivery step 2 inbound	[km]	50	50	50	50	50	50	50	50	50
delivery total	[km]	400	400	400	600	600	600	400	600	400
cooling lorry needed (1 = yes)	[-]	0	0	0	0	0	0	0	0	0

waste management	unit	PET OW	rPET 50% OW	rPET 100% OW	PET MW	rPET 50% MW	rPET 100% MW	Glass OW	Glass MW	ALU can
allocation benefit recycling	[%]	50%	50%	50%	50%	50%	50%	50%	50%	50%

Results – CSD

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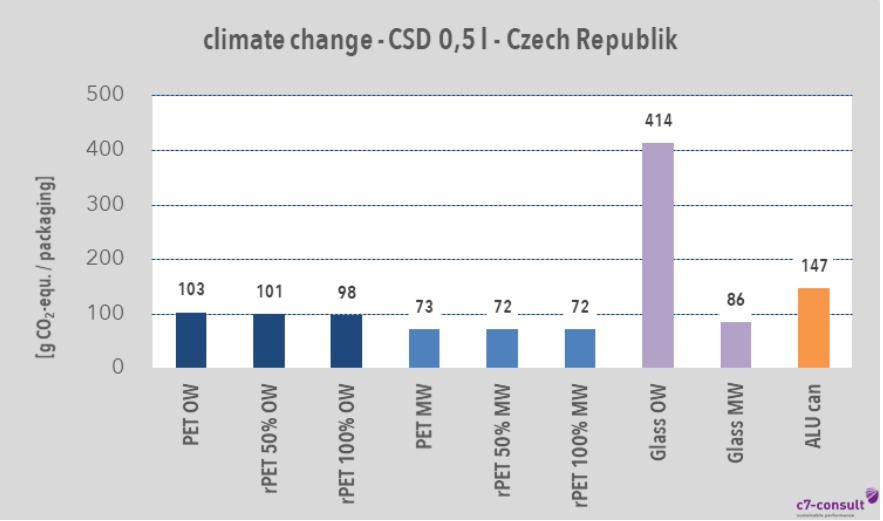

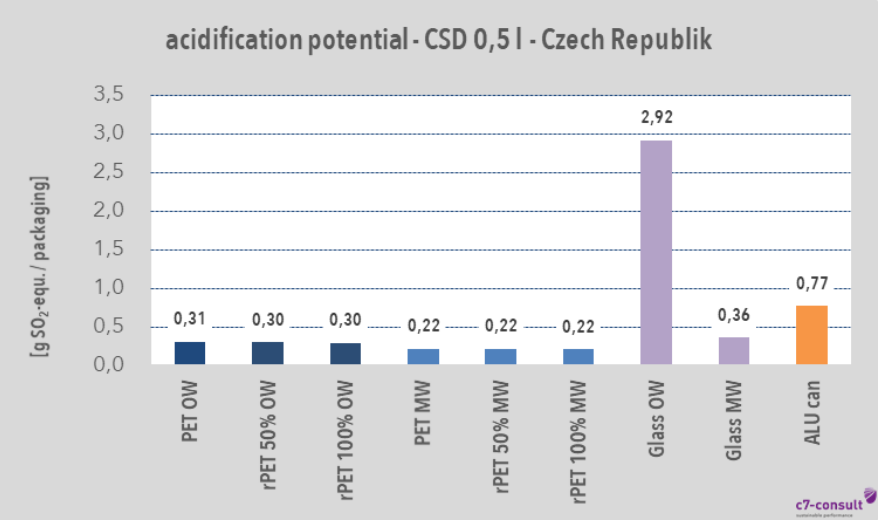

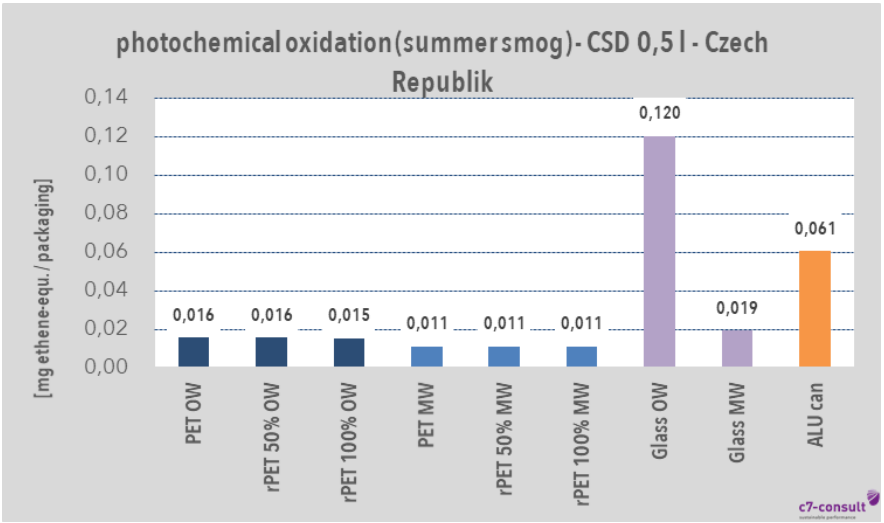

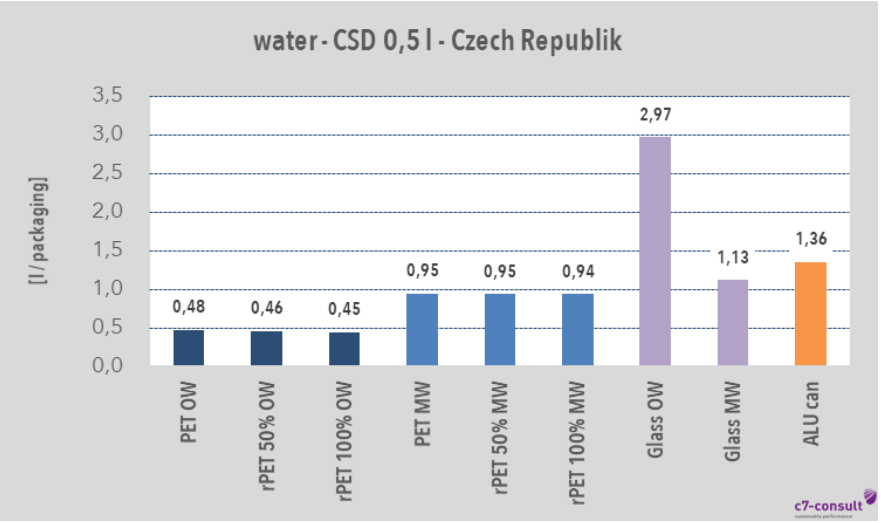

Input data – food jar

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food jar 0,35 l	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	FE can
volume	[ml]	350	350	350	310	420
cycles	[-]	1	1	1	1	1
mass of container	[g]	19,19	19,19	19,19	162,66	46,05
material cap	[-]	PP	PP	PP	Tinplate	Tinplate
mass cap	[g]	9,54	9,54	9,54	11,50	10,02
material label	[-]	paper	paper	paper	paper	paper
mass label	[g]	1,00	1,00	1,00	0,80	1,78
mass product system: container, cap & label	[g]	29,73	29,73	29,73	174,96	57,85

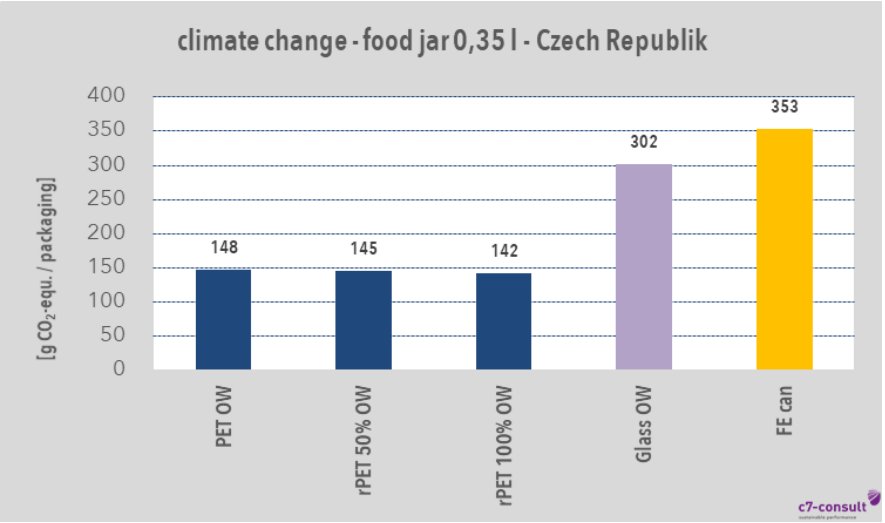
secondary packaging / sales packaging	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	FE can
container per tray/box	[pieces]	6	6	6	6	6
mass materials single use	[g]	161,00	161,00	161,00	161,00	161,00
mass materials multiple use	[g]	-	-	-	-	-

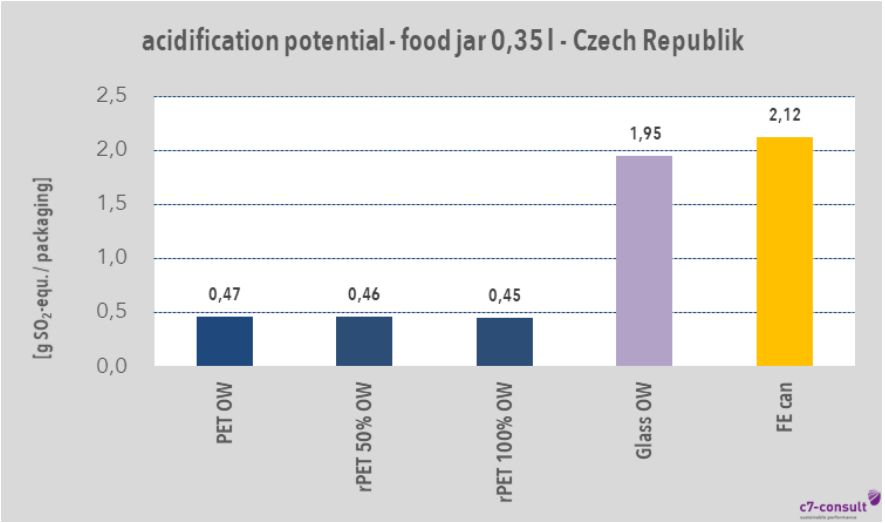
tertiary packaging / transport packaging per palette	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	FE can
trays/boxes per layer	[pieces]	40	40	40	40	38
layer per palette	[pieces]	8	8	8	7	8
container per palette	[pieces]	1.920	1.920	1.920	1.680	1.824

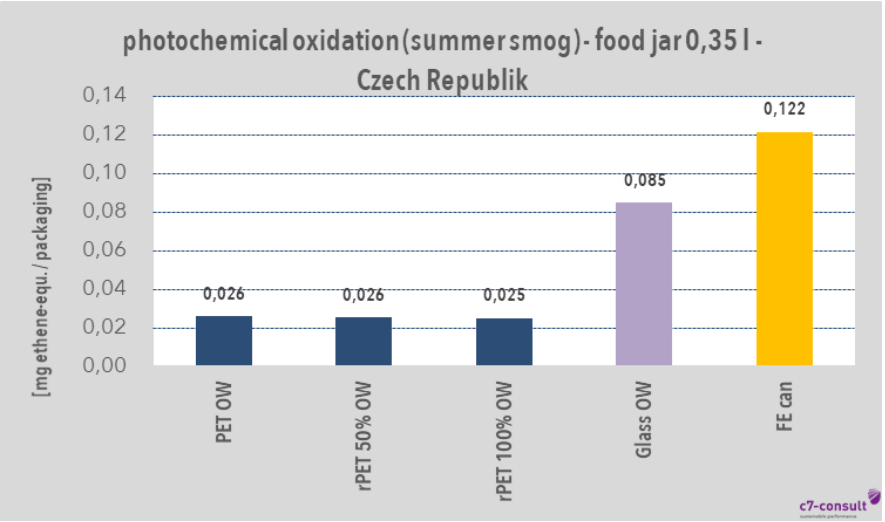
delivery to retailer	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	FE can
mass for transport total	[kg]	21.033	21.033	21.033	23.125	24.723
container per lorry	[pieces]	49.920	49.920	49.920	43.680	47.424
delivery step 1 outbound	[km]	300	300	300	300	300
delivery step 1 inbound	[km]	60	60	60	60	60
delivery step 2 outbound	[km]	50	50	50	50	50
delivery step 2 inbound	[km]	50	50	50	50	50
delivery total	[km]	460	460	460	460	460
cooling lorry needed (1 = yes)	[-]	0	0	0	0	0

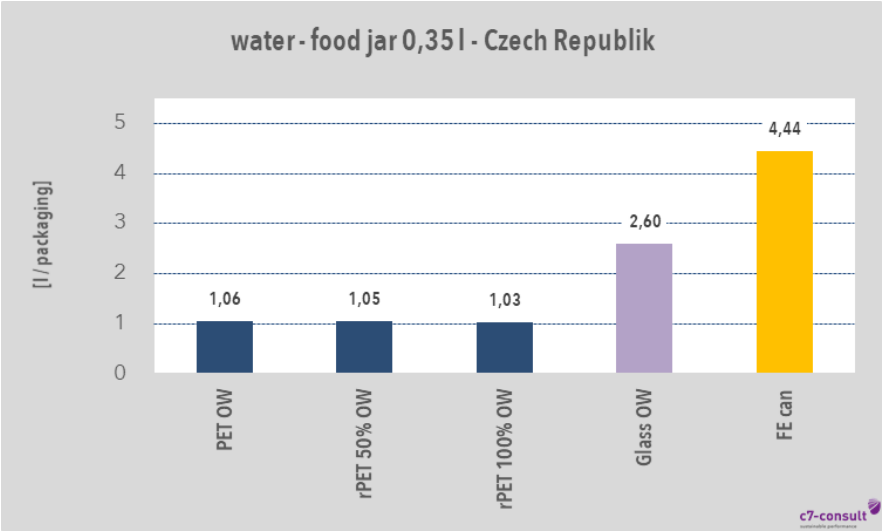
waste management	unit	PET OW	rPET 50% OW	rPET 100% OW	Glass OW	FE can
allocation benefit recycling	[%]	50%	50%	50%	50%	50%

Results – food jar









Input data – ketchup

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ketchup 0,3 l	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	PP	Glass OW
volume	[ml]	320	320	320	370	370	370	270	330
cycles	[-]	1	1	1	1	1	1	1	1
mass of container	[g]	21,85	21,85	21,85	25,45	25,45	25,45	22,21	191,09
material cap	[-]	PP	PP	PP	PP	PP	PP	PP	Tinplate
mass cap	[g]	3,39	3,39	3,39	6,93	6,93	6,93	4,60	3,17
material label	[-]	PP	PP	PP	PP	PP	PP	PP	paper
mass label	[g]	0,76	0,76	0,76	1,51	1,51	1,51	0,65	0,76
mass product system: container, cap & label	[g]	26,00	26,00	26,00	33,89	33,89	33,89	27,46	195,02

secondary packaging / sales packaging	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	PP	Glass OW
container per tray/box	[pieces]	6	6	6	6	6	6	6	6
mass materials single use	[g]	134,00	134,00	134,00	134,00	134,00	134,00	134,00	138,00
mass materials multiple use	[g]	-	-	-	-	-	-	-	-

tertiary packaging / transport packaging per palette	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	PP	Glass OW
trays/boxes per layer	[pieces]	40	40	40	40	40	40	40	40
layer per palette	[pieces]	8	8	8	8	8	8	8	7
container per palette	[pieces]	1.920	1.920	1.920	1.920	1.920	1.920	1.920	1.680

delivery to retailer	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	PP	Glass OW
mass for transport total	[kg]	19.187	19.187	19.187	22.077	22.077	22.077	16.764	24.753
container per lorry	[pieces]	49.920	49.920	49.920	49.920	49.920	49.920	49.920	43.680
delivery step 1 outbound	[km]	300	300	300	300	300	300	300	300
delivery step 1 inbound	[km]	60	60	60	60	60	60	60	60
delivery step 2 outbound	[km]	50	50	50	50	50	50	50	50
delivery step 2 inbound	[km]	50	50	50	50	50	50	50	50
delivery total	[km]	460	460	460	460	460	460	460	460
cooling lorry needed (1 = yes)	[-]	0	0	0	0	0	0	0	0

waste management	unit	PET OW	rPET 50% OW	rPET 100% OW	HDPE	rHDPE 50%	rHDPE 100%	PP	Glass OW
allocation benefit recycling	[%]	50%	50%	50%	50%	50%	50%	50%	50%

Results – ketchup

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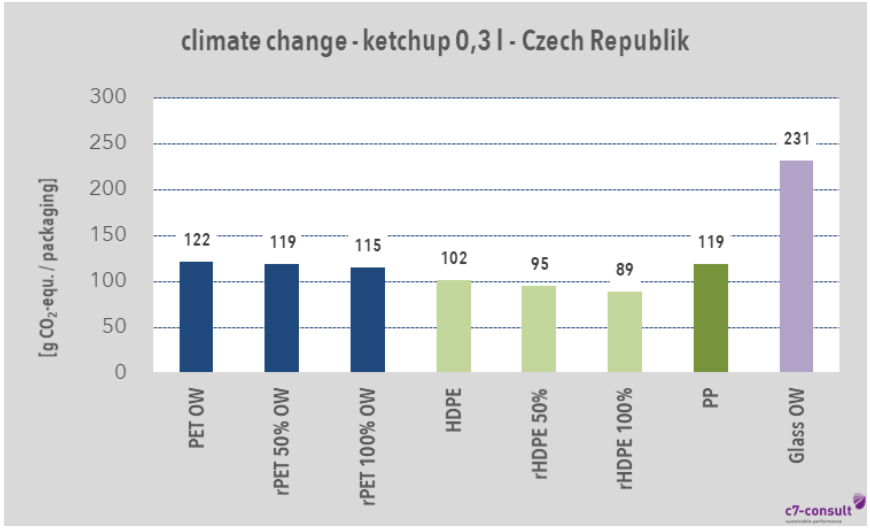

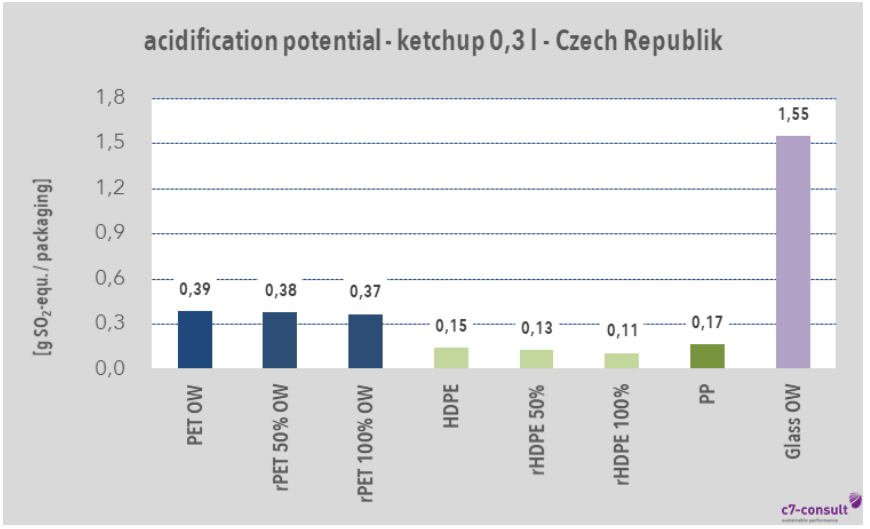

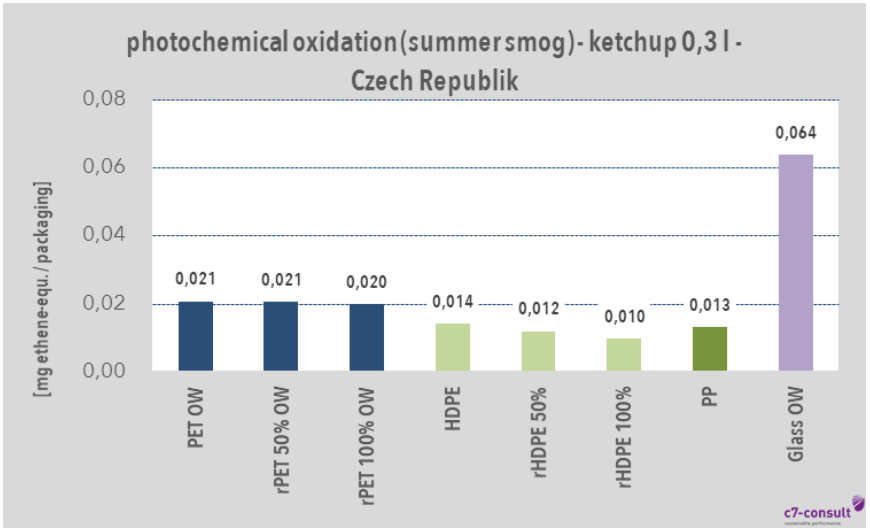

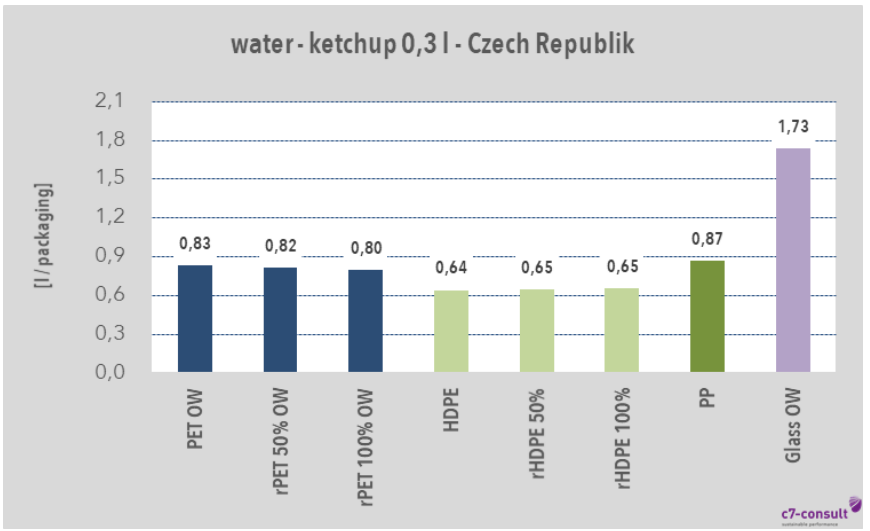

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Summary

Summary

- Fe cans and glass one-way bottles cause highest environmental impacts.
- The use of electricity from renewable sources and the use of rPET from ALPLA's PET RECYCLING TEAM in Wöllersdorf or Radomsko could significantly improve the balance of PET bottles.
  - A higher rate of separate collection and recycling would also improve the results of PET one-way bottles.
- All investigated PET multiple-way bottles for mineral water and CSD perform best compared to other beverage packaging, although the returnable bottles need twice the amount of water than one-way bottles.

Summary

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- For milk the ultralight-weight HDPE bottle from Great Britain performs best.
  - Also beverage carton show less environmental impacts than PET one-way bottles.
  - PET one-way bottles with a high share of recycling content perform better than glass multi-way bottles.
- The environmentally friendliest packaging for beer is the multi-way glass bottle.
- The case study for CSD shows, that PET one-way bottles perform - besides climate change - better than glass multi-way bottles.
- The aluminium can for beer and CSD cause high environmental impacts.

Summary

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- The case study packaging for food jar shows a clear winner: PET container have much lower environmental impacts than Fe can and single use glass container.
- For ketchup HDPE bottles perform better than other packaging materials. PP bottles seems to be slightly better than PET bottles.
- PET multi-way bottles should reach a refill rate of at least 8 - 10, a glass multi-way bottle at least 16. A further increase has only low impacts on the ecological performance.
- The sensitivity analysis of input data which are most relevant for final results show that chosen refill rate and transport distances are conservative high and favour multi-way systems.

THANK YOU
for your attention!

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