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Product Carbon Footprint
TRAYS for 150 g Cheese

symbolic image

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MEMBER OF TEAM ZF

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Aim of the Study

Aim of the Study

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- The aim of the study is to compare the Product Carbon Footprint of trays for 150 g Cheese made from
  - 100% rPET, 91 % rPET, PET, PP, and coated cardboard.
- The system boundary includes the production of the trays, delivery for filling, delivery to the central warehouse and food retailing, transport to recycling facilities (mechanical recycling or incineration plant) as well as material or energy recovery at the end of life.
- Not included – since identical for all materials:
  - Lid or closure
  - Label and printing
  - Filling.
- The content (cheese) is not being balanced and is not considered for transportation.

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Method
Product Carbon Footprint

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Method

- The carbon footprint is calculated based on the standards ISO 14044 Life Cycle Assessment and ISO 14067 - Greenhouse Gases - Carbon Footprint of Products - Requirements and Guidelines for Quantification.
  - According to PEF - Product Environmental Footprint, the 50:50 approach is chosen for the allocation at the End of Life. This means that 50 % of the burdens for recycling and recovery as well as 50 % of the benefits for substituted primary material production or electricity and heat production are credited to the product.

Definition of Product Carbon Footprint

- The Product Carbon Footprint provides information about the total greenhouse gas emissions that are caused by a product over the entire life cycle.
- It is calculated in kg CO_2-equivalent for a defined functional unit and includes:
  - Emissions in the life cycle phases production, use and recycling / disposal (End of Life)
  - Emissions from the production and supply of energy and raw materials
  - Substitution effects through recycling and recovery

Greenhouse Gases
Source: Greenhouse Gas Protocol (extract)

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Industrial designation or common name	Chemical formula	GWP values for 100-year time horizon		
		Second Assessment Report (SAR)	Fourth Assessment Report (AR4)	Fifth Assessment Report (AR5)
Carbon dioxide	CO_2	1	1	1
Methane	CH_4	21	25	28
Nitrous oxide	N_2O	310	298	265
Substances controlled by the Montreal Protocol				
CFC-11	CCl_3F	3,800	4,750	4,660
CFC-12	CCl_2F_2	8,100	10,900	10,200
CFC-13	$CClF_3$		14,400	13,900
CFC-113	CCl_2FCClF_2	4,800	6,130	5,820
CFC-114	$CClF_2CClF_2$		10,000	8,590
CFC-115	$CClF_2CF_3$		7,370	7,670
Halon-1301	$CBrF_3$	5,400	7,140	6,290
Halon-1211	$CBrClF_2$		1,890	1,750
Halon-2402	$CBrF_2CBrF_2$		1,640	1,470
Carbon tetrachloride	CCl_4	1,400	1,400	1,730
Methyl bromide	CH_3Br		5	2
Methyl chloroform	CH_3CCl_3	100	146	160

Approach

1. Definition of the functional unit and system boundaries
2. Data collection: Masses and materials of the components, production of components, energy supply (energy mix), distances for transport, waste management conditions like share of separate collection, recycling rates
3. Transformation of data into life cycle data (CO_2-equivalent)
4. Balancing throughout the entire life cycle
   - cradle to grave approach
5. Sensitivity analysis, conclusions, and interpretation of results

The Analysis includes in Detail

- Production of raw material for the trays, delivery of the raw materials to tray production as well as the tray production itself
- Transport to Filling
- Delivery to retailer
- End of life treatment (mechanical recycling and energy recovery) of trays for cheese

Sample image of packaging units for 150g content, analysis without sealing film

Outside the System Boundaries

- Production of content cheese
- Recycling of production waste
- Filling
- Losses during transportation and storage
- Losses caused by damaged packaging

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Input Data

Input Data
TRAY for 150 g Cheese

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Tray for 150 g Cheese	Measuring unit	100 % rPET	91 % rPET	PET	PP	foil on card-board	cardbord	cardboard coated
Basic Material	[-]	PET	PET	PET	PP	LDPE	card-board	cardboard & LDPE
Mass tray for 150 g Cheese	[g]	7,67	7,67	7,67	5,83	1,35	6,04	7,39
Share recycled material	[%]	100%	91%	0%	0%	0%	75%	61%
Share virgin material	[%]	0%	9%	100%	100%	100%	25%	99%
Number of circulations	[-]	1	1	1	1	1	1	1
Scrap thermoforming – recycled inhouse	[%]	20%	20%	20%	20%	0%	0%	0%
EVOH	[%]				5%			
EVA	[%]				5%			
Delivery Basic Material								
Basic Material	[km]	750	750	750	750	750	300	-
EVOH	[km]	-	-	-	750	-	-	-
EVA	[km]	-	-	-	750	-	-	-
Production Tray for 150 g Cheese								
Production sheet PET, PP, PS – not rPET	[kWh / kg]	-	-	0,50	0,50	0,05	0,05	0,10
Energy consumption thermoforming	[Wh / kg]	105	105	105	278	-	-	-

Input Data
TRAY for 150 g Cheese

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Delivery to Filling	Measuring unit	100 % rPET	91 % rPET	PET	PP	foil on card-board	cardbord	cardboard coated
Tray for 150 g Cheese (incl. Empty run)	[km]	150	150	150	150	150	150	150
Sheet Cheese Trays per truck	[Mio. pcs.]	3,13	3,13	3,13	4,12	17,78	3,97	
Fuel consumption truck	[l / 100 km]	35	35	35	35	35	35	35
Delivery	Measuring unit	100 % rPET	91 % rPET	PET	PP	foil on card-board	cardbord	cardboard coated
Filler - Central warehouse	[km]	350	350	350	350	350	350	350
Central warehouse – Food retailer	[km]	140	140	140	140	140	140	140
Cheese trays per truck	[pcs.]	16.128	20.736	20.736	20.736	41.472	20.736	20.736
Mass per truck excluding content of packaging	[kg]	2.469	2.955	2.955	2.916	2.852	2.921	2.949
Transported mass per Tray for 150 g Cheese	[kg]	0,008	0,008	0,008	0,006	0,001	0,006	0,007

Input Data
TRAY for 150 g Cheese

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End of life treatment	Measuring unit	100 % rPET	91 % rPET	PET	PP	foil on card-board	cardbord	cardboard coated
Distance to recycling of plastics	[km]	250	250	250	250	250	250	250
Distance waste incineration plant	[km]	200	200	200	200	0%	-	0%
Separate collection plastics	[%]	50%	50%	50%	50%			
Yield Recycling plastics	[%]	75%	75%	75%	50%	0%	0%	0%
Fossil carbon content plastics	[g CO2 / g]	2,29	2,29	2,29	3,14	3,38		
Energy efficiency Gas Power Plant for distance heating	[%]	90%	90%	90%	90%	90%	90%	90%
Waste incineration plant: share of type “heat”	[%]	70%	70%	70%	70%	70%	70%	70%
Waste incineration plant: share of type “electricity”	[%]	30%	30%	30%	30%	30%	30%	30%
Energy efficiency (distance heating)	[%]	75%	75%	75%	75%	75%	75%	75%
Energy efficiency (electricity)	[%]	21%	21%	21%	21%	21%	21%	21%

-

Allocation end of life	Measuring unit	100 % rPET	91 % rPET	PET	PP	foil on card-board	cardbord	cardboard coated
Allocation end of life	[%]	50%	50%	50%	50%	50%	50%	50%
Downcycling PP recycling (reduction)	[%]				33%			

Input Data
TRAY for 150 g Cheese

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- All relevant steps of the packaging production take place in Austria.
  - Green electricity is assumed for the electricity mix
- It is assumed that the thermoforming of the trays is done at the site of the food manufacturer.
- The distribution from the food manufacturer to the central warehouse and on to the retailer is done with trucks with refrigeration machine.
- Waste Management
  - A 50 % material recycling rate is assumed for PET
  - A 50 % material recycling rate is assumed for PP. For PP a further reduction of 33% is assumed due to downcycling, because recycled PP granulates are not allowed for packaging with food contact in the European Union.
  - Not mechanically recycled material and the coated cardboard tray are collected with the residual waste and used for energy recovery in waste incineration plants.

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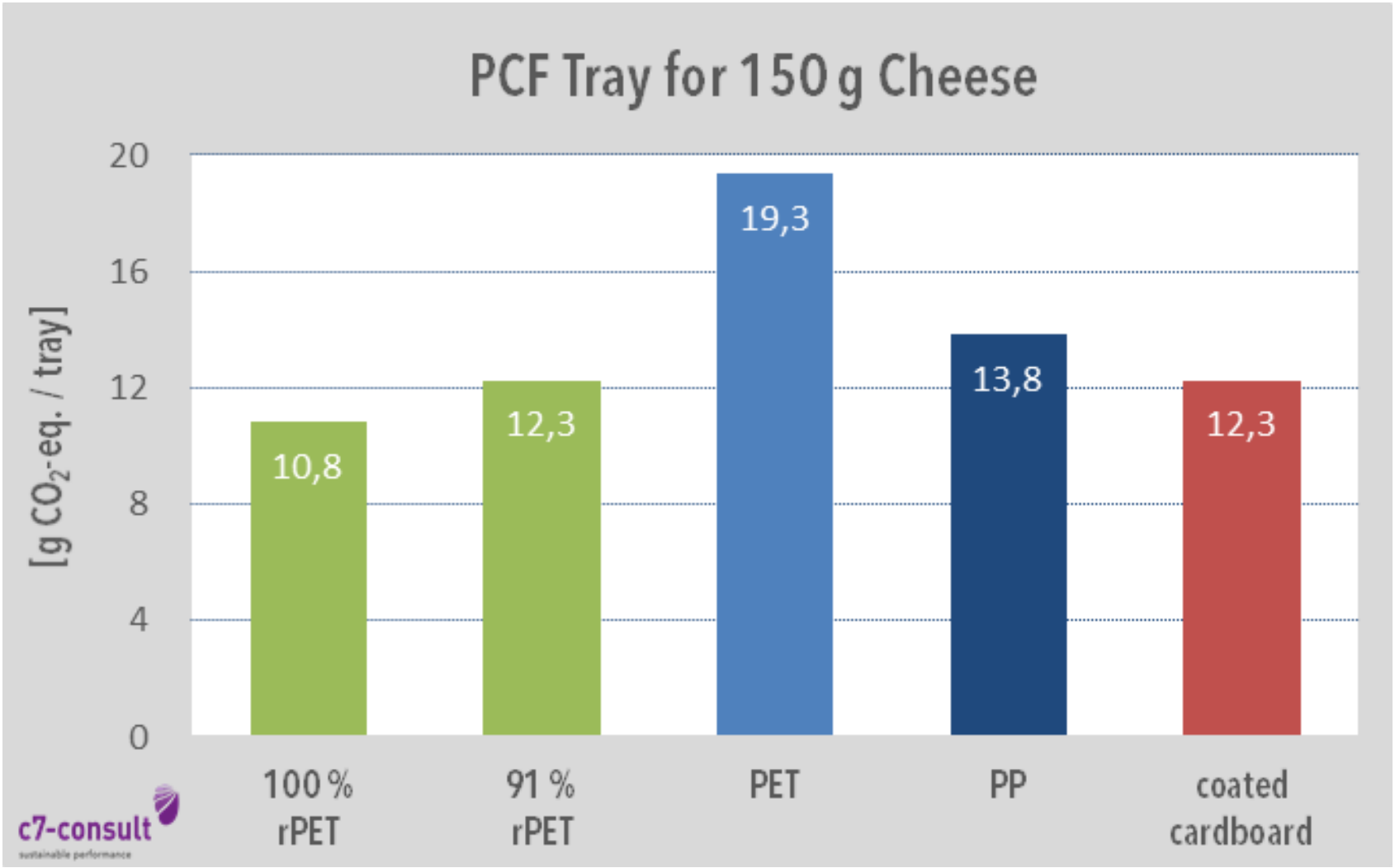
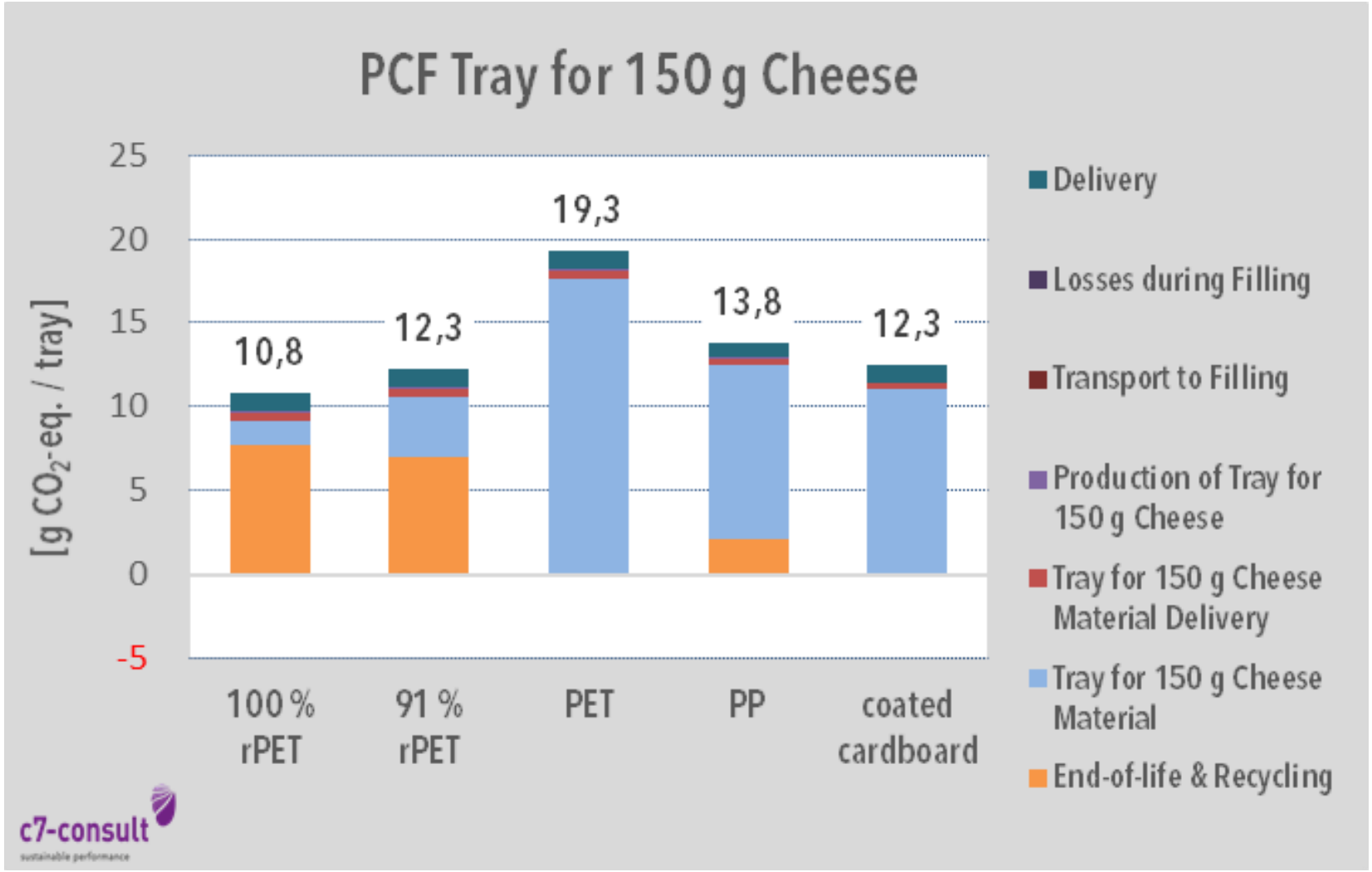
Results

Results
Product Carbon Footprint of Cheese Tray



Results
Product Carbon Footprint of Cheese Tray



Results
Product Carbon Footprint of Cheese Tray

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PCF Tray for 150 g Cheese	PCF [g CO_2-eq. / piece]				
Material	100 % rPET	91 % rPET	PET	PP	coated cardboard
Tray for 150 g Cheese Material	1,45	3,55	17,53	10,33	11,09
Tray for 150 g Cheese Material Deli	0,52	0,52	0,52	0,40	0,26
Production of Tray for 150 g Chees	0,02	0,02	0,09	0,09	0,01
Transport to Filling	0,05	0,05	0,05	0,04	0,05
Losses during Filling	0,00	0,00	0,02	0,01	0,00
Delivery	1,09	1,09	1,09	0,83	1,05
End-of-life & Recycling	7,70	7,03	0,04	2,13	- 0,19
	10,8	12,3	19,3	13,8	12,3

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Conclusions
Cheese Tray

Conclusions
TRAY for 150 g Cheese

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- The tray for 150 g cheese made from 100 % rPET causes the lowest greenhouse gas emissions with 10.8 g CO_2-eq.
  - The cheese tray made from 91 % rPET and the coated cardboard tray both cause 12.3 g CO_2-eq. per tray.
  - The cheese trays made from PET and PP using 100 % virgin material cause higher emissions with values of 19.3 and 13.8 g CO_2-eq.
- For the trays made from plastic material a separate collection rate of 50 % and subsequent recycling is assumed. The coated cardboard tray is recycled thermally together with the residual waste.
  - Some losses in the recycling process of PET cannot be avoided. In case of the tray made from 100% rPET this results in a small portion of the used rPET being lost in each recycling loop. It is necessary to compensate for this losses with virgin material.

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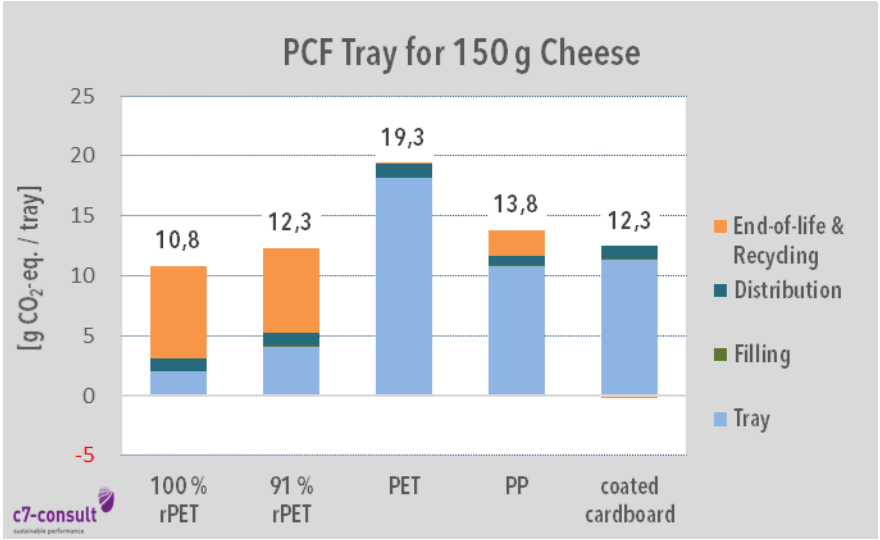
Summary

Summary
TRAY for 150 g Cheese

- The trays for 150 g Cheese made from 100 % rPET score best in terms of climate change, causing 10.8 g CO_2-eq. Both the tray made from 91 % rPET and a cardboard tray coated with plastics cause 12.3 g CO_2-eq. per tray.
- Of the trays made from virgin plastics, the PET Tray (with 19.3 g CO_2-eq.) scores considerably higher than the PP-tray (with 13.8 g CO_2-eq.).



Thank you
for your attention!

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