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Product Carbon Footprint
TRAYs for 350 g MEAT

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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 350 g meat made from
  - 100% rPET, 60 % rPET, PET, and PP.
- 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 (meat) 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

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- 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 of the trays (mechanical recycling and energy recovery)

Sample image of Packaging unit for 350g content, analysis without sealing film

Outside the System Boundaries

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

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Input Data

Input Data
MEAT TRAY

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Tray for 350g meat	Measuring unit	100 % rPET	60 % rPET	PET	PP
Basic Material	[-]	PET	PET	PET	PP
Mass of meat tray	[g]	17,88	17,88	17,88	13,91
Share recycled material	[%]	100%	60%	0%	0%
Share virgin material	[%]	0%	40%	100%	100%
Number of circulations	[-]	1	1	1	1
Scrap thermoforming – recycled inhouse	[%]	20%	20%	20%	20%
EVOH	[%]				5%
EVA	[%]				5%
Delivery Basic Material					
Material	[km]	750	750	750	750
EVOH	[km]	750	750	750	750
EVA	[km]	750	750	750	750
Production Meat Tray					
Production sheet PET, PP – not rPET (included in rPET)	[kWh / kg]	-	-	0,50	0,50
Energy consumption thermoforming	[Wh / kg]	105	105	105	278

Input Data
MEAT TRAY

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Delivery to Filling	Measuring unit	100 % rPET	60 % rPET	PET	PP
Meat Tray (incl. empty run)	[km]	150	150	150	150
Sheet Meat Tray	[pcs.]	1.342.282	1.342.282	1.342.282	1.725.377
Fuel consumption truck	[l / 100 km]	35	35	35	35
Delivery	**Measuring unit**	**100 % rPET**	**60 % rPET**	**PET**	**PP**
Filler - Central warehouse	[km]	350	350	350	350
Central warehouse – Food retailer	[km]	140	140	140	140
Meat trays per truck	[pcs.]	13.824	13.824	13.824	13.824
Mass per truck excluding content of packaging	[kg]	3.043	3.043	3.043	2.988
Transported mass per Tray for 350g meat	[kg]	0,018	0,018	0,018	0,014

Input Data
MEAT TRAY

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End of life treatment	Measuring unit	100 % rPET	60 % rPET	PET	PP
Distance to recycling of plastics	[km]	250	250	250	250
Distance waste incineration plant	[km]	200	200	200	200
Separate collection plastics	[%]	80%	80%	80%	80%
Yield recycling plastics	[%]	75%	75%	75%	50%
Fossil carbon content plastics	[g CO_2 / g]	2,29	2,29	2,29	3,14
Energy efficiency Gas Power Plant for distance heating	[%]	90%	90%	90%	90%
Waste incineration plant: share of type “heat”	[%]	70%	70%	70%	70%
Waste incineration plant: share of type “electricity”	[%]	30%	30%	30%	30%
Energy efficiency (distance heating)	[%]	75%	75%	75%	75%
Energy efficiency (electricity)	[%]	21%	21%	21%	21%

Allocation end of life	Measuring unit	100 % rPET	60 % rPET	PET	PP
Allocation end of life	[%]	50%	50%	50%	50%
Downcycling PP recycling (reduction)	[%]				33%

Input Data
MEAT TRAY

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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 80 % material recycling rate is assumed for PET
  - A 80 % 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
Meat Tray

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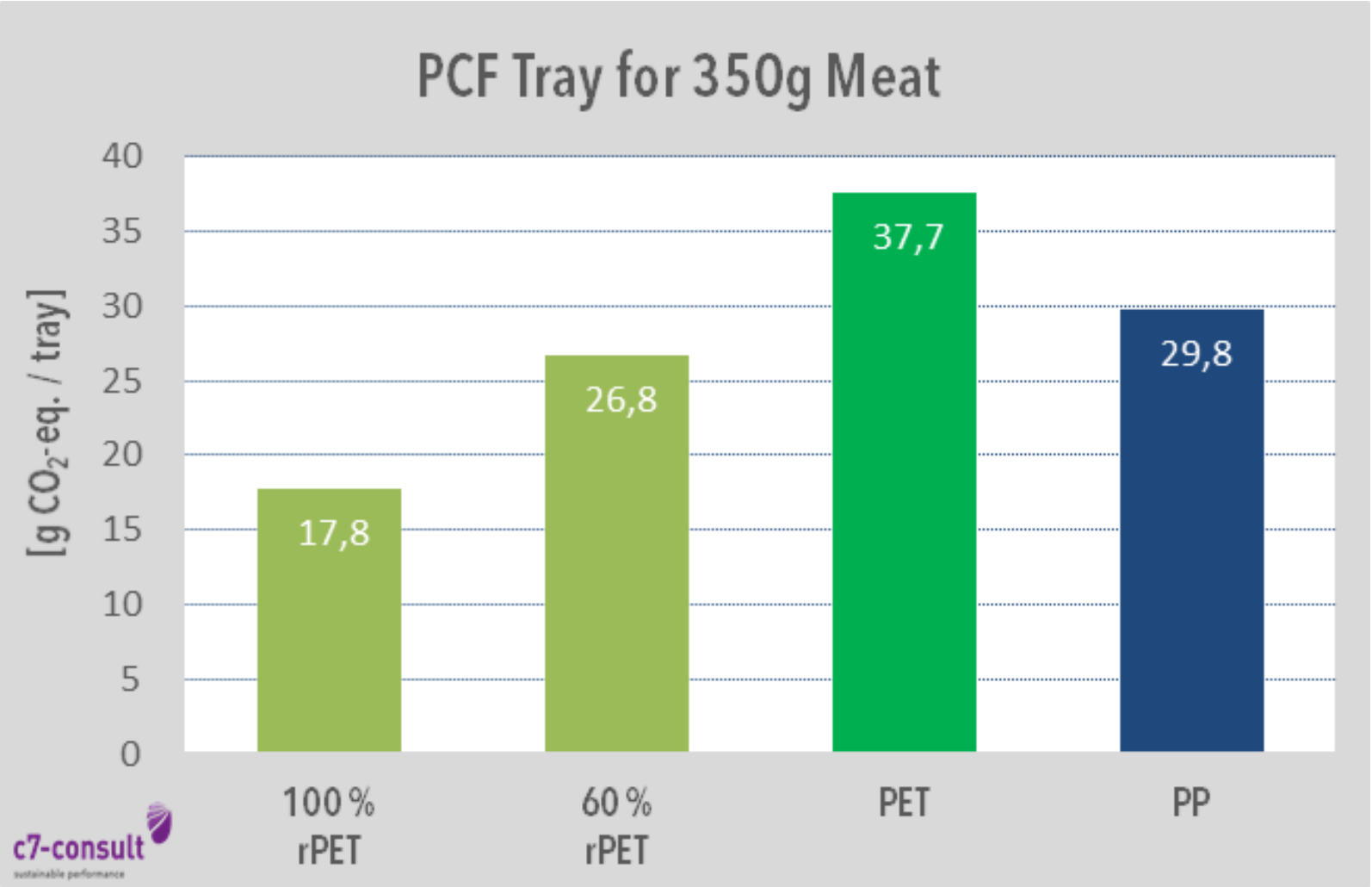
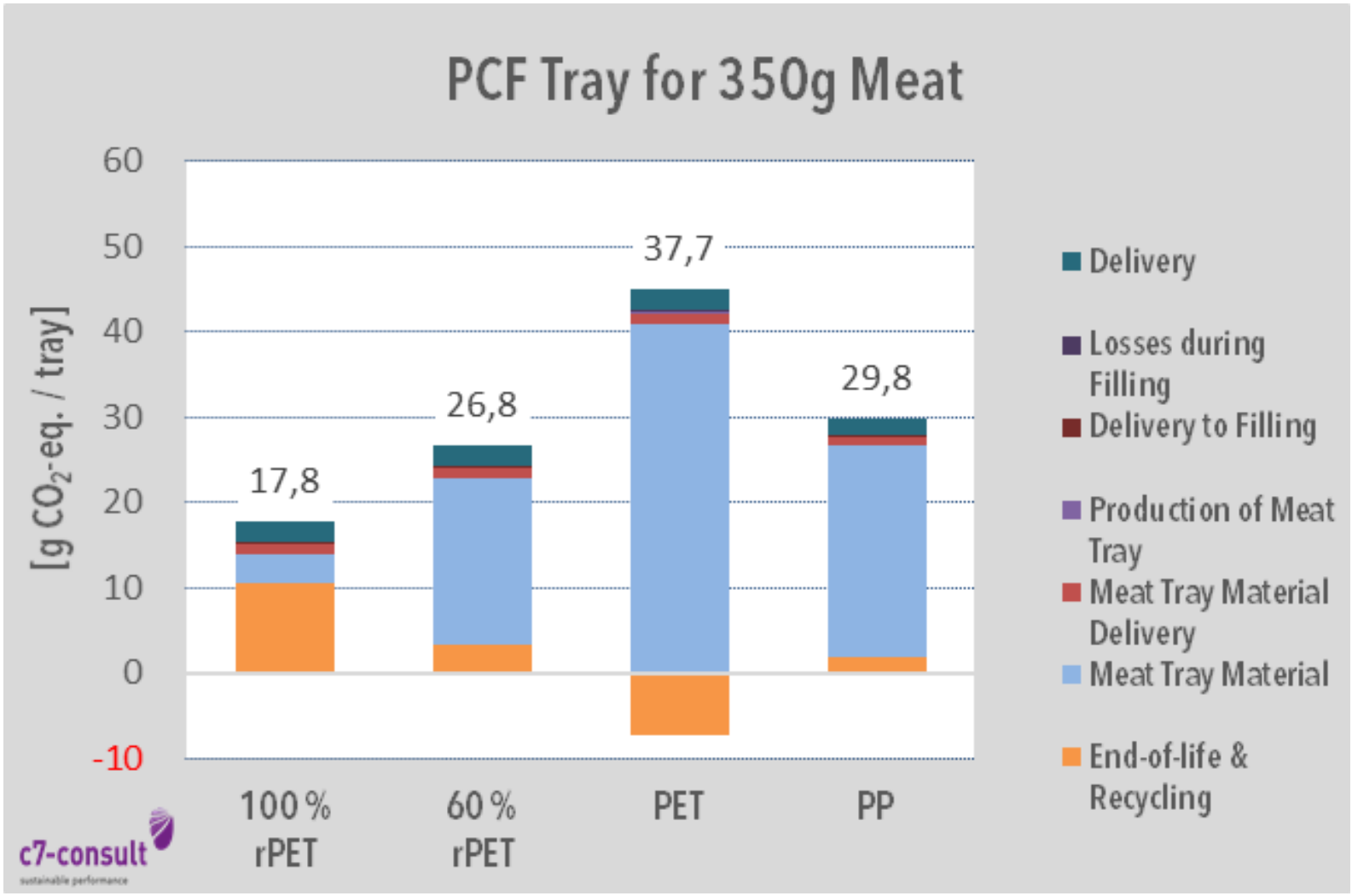


Results Product Carbon Footprint
Meat Tray



Results Product Carbon Footprint
Meat Tray

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PCF Tray for 350g Meat	PCF [g CO_2-eq. / piece]			
Material	100 % rPET	60 % rPET	PET	PP
Meat Tray Material	3,38	19,45	40,86	24,65
Meat Tray Material Delivery	1,22	1,22	1,22	0,95
Production of Meat Tray	0,04	0,04	0,21	0,21
Delivery to Filling	0,12	0,12	0,12	0,09
Losses during Filling	0,00	0,02	0,04	0,03
Delivery	2,53	2,53	2,53	1,97
End-of-life & Recycling	10,51	3,37	- 7,34	1,94
	17,8	26,8	37,7	29,8

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Conclusions
MEAT TRAY

Conclusions
TRAY for 350g MEAT

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- The tray for 350 g meat made from 100 % rPET causes the lowest greenhouse gas emissions with 18 g CO_2-eq., a tray made from 60 % rPET causes 27 g CO_2-eq.
- The two meat trays made from virgin PET and virgin PP cause significantly higher greenhouse emissions with 38 and 30 CO_2-eq.
- For the trays a separate collection rate of 80 % and subsequent mechanical recycling is assumed.
  - 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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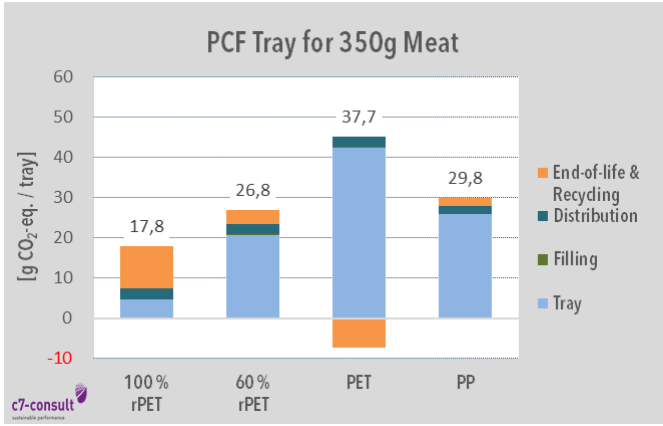
Summary

Summary
TRAY for 350g MEAT

- Meat Trays made from PET with recycled content share cause less green house emissions than meat trays made from virgin PET or virgin PP. The higher the share of recyclate, the lower the Product Carbon Footprint. A tray made from 100 % rPET causes 18 g CO_2-eq., a tray made from PET 38 g CO_2-eq.
  - In contrast to other plastics, PET has the advantage that collected post-consumer PET trays can be again recycled into new PET trays which are food-grade and approved for food contact.
  - For 100 % rPET tray the end-of-life & recycling counts for the biggest share, since the portion of the not recycled material must be compensated with virgin material.



Thank you
for your attention!

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