LBP GaBi – Department Life Cycle Engineering

University of Stuttgart

Chair of Building Physics

Life Cycle Engineering

Calculating and Illustrating Environmental Impacts of Fresh Fruit and Vegetable Packaging and Transport -the SIM-Study and -Tool

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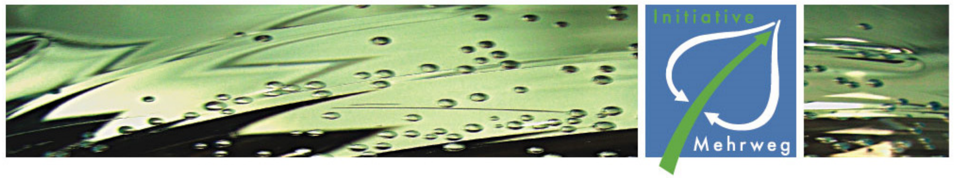
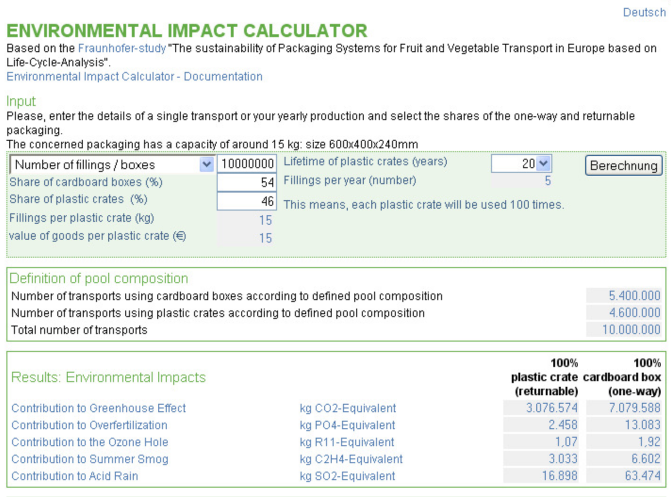




Deutsch

ENVIRONMENTAL IMPACT CALCULATOR

Based on the Fraunhofer-study "The sustainability of Packaging Systems for Fruit and Vegetable Transport in Europe based on Life-Cycle-Analysis".

Environmental Impact Calculator - Documentation

Input

Please, enter the details of a single transport or your yearly production and select the shares of the one-way and returnable packaging.

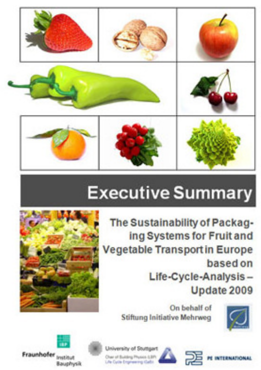
The concerned packaging has a capacity of around 15 kg: size 600x400x240mm

Number of fillings / boxes	10000000	Lifetime of plastic crates (years)	20	Berechnung
Share of cardboard boxes (%)	54	Fillings per year (number)	5	
Share of plastic crates (%)	46	This means, each plastic crate will be used 100 times.		
Fillings per plastic crate (kg)	15			
value of goods per plastic crate (€)	15			

Definition of pool composition

Number of transports using cardboard boxes according to defined pool composition	5.400.000
Number of transports using plastic crates according to defined pool composition	4.600.000
Total number of transports	10.000.000

Results: Environmental Impacts		100% plastic crate (returnable)	100% cardboard box (one-way)
Contribution to Greenhouse Effect	kg CO2-Equivalent	3.076.574	7.079.588
Contribution to Overfertilization	kg PO4-Equivalent	2.458	13.083
Contribution to the Ozone Hole	kg R11-Equivalent	1,07	1,92
Contribution to Summer Smog	kg C2H4-Equivalent	3.033	6.602
Contribution to Acid Rain	kg SO2-Equivalent	16.898	63.474



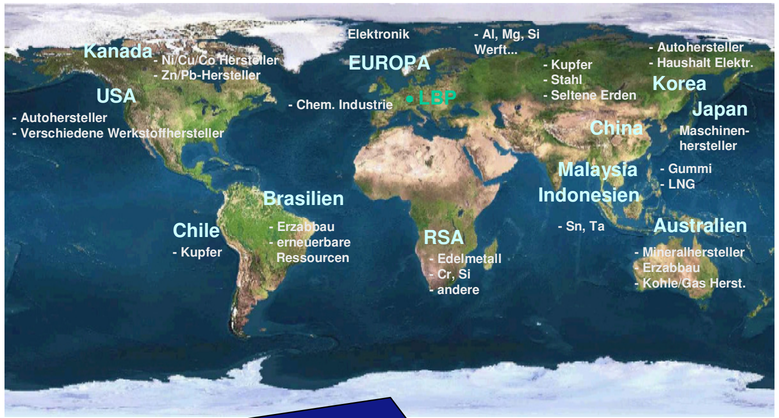
University of Stuttgart

Chair of Building Physics

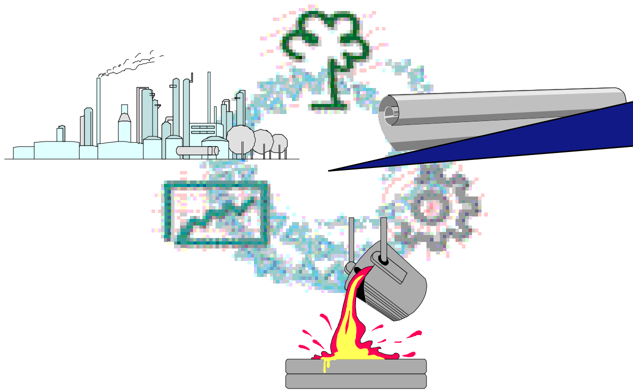
Life Cycle Engineering

Chair of building physics – Department Life Cycle Engineering

- Founded 1989 – Prof. Dr.-Ing. Peter Eyerer (IKP), since 2006 chair for building physics (LBP) of Prof. Dr.-Ing. Dipl.-Phys. Klaus Sedlbauer
- Interdisciplinary team of 12 full time academic staff (Chemical, mechanical, environmental, industrial and process engineers; geoecologist, economist)



Industry and research projects on ecological-economic-technical analysis and decision-support of products, processes and services



Methodology development (Life Cycle Engineering and Sustainability, substance flow analysis, Indicators)

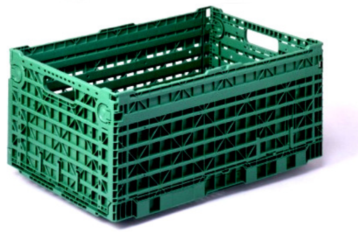
GaBi Software
PRODUCT SUSTAINABILITY

Software and database development and maintenance (GaBi software, DfE-tools)

Outline

- SIM Study
  - System regarded
  - Results
- Impact Calculator
  - Inputs
  - Outputs
  - Example
- Discussion and Conclusions

Wooden boxes (one-way)	Cardboard boxes (one way)	Plastic crates (multi-way)

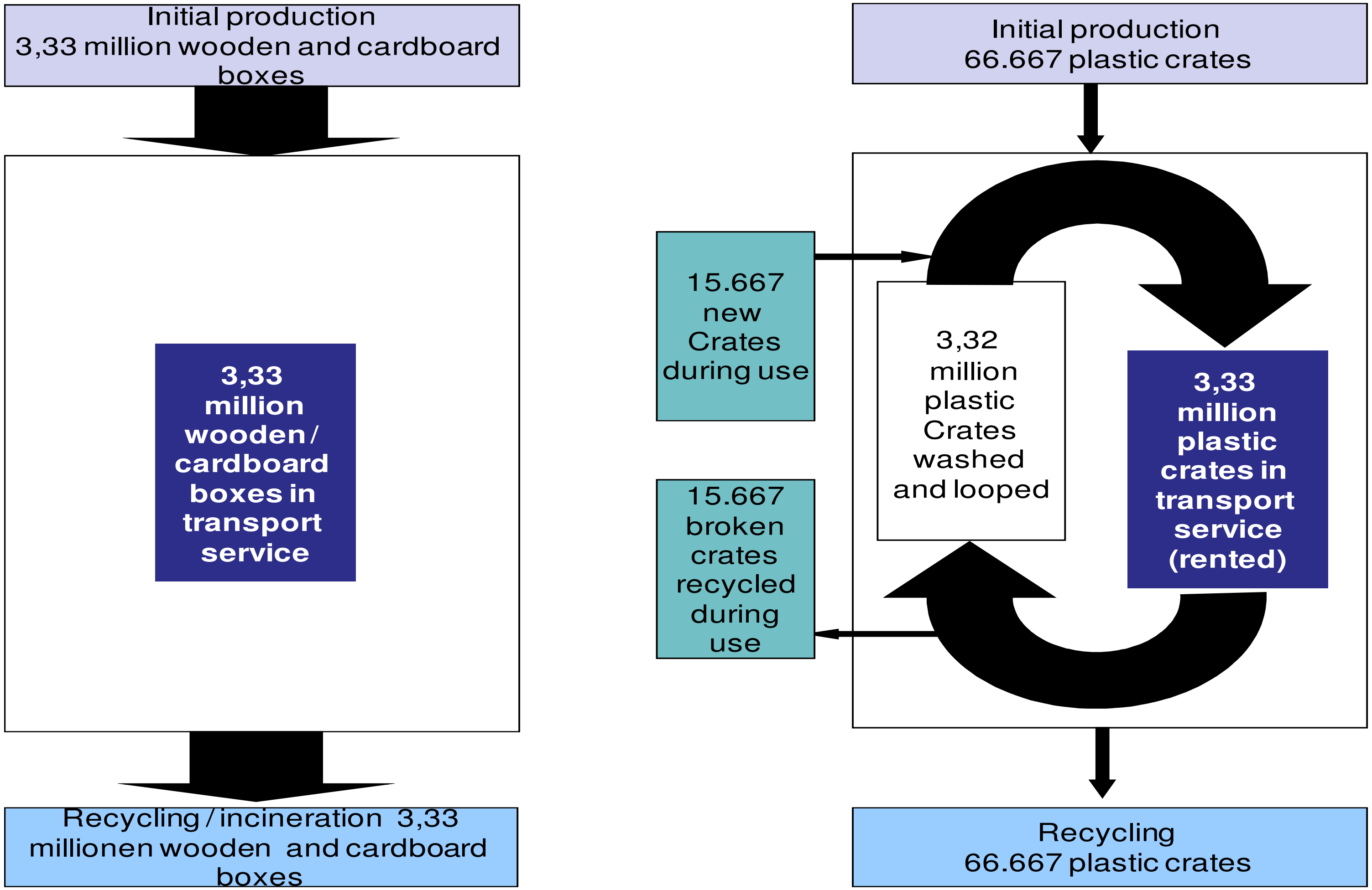


Goal and Scope

- LCA of the production, utilisation and end-of-life of three fruit and vegetable packaging systems (wooden boxes, cardboard boxes and plastic crates) including transport and distribution
  - Primary energy use, separated into renewable and non-renewable energy use [MJ]
  - Global warming potential GWP100 [kg CO_2 equivalents],
  - Ozone depletion potential ODP [kg R11 equivalents],
  - Acidification potential AP [kg SO_2 equivalents],
  - Eutrophication potential EP [kg PO_4^{3-} equivalents],
  - Photochemical ozone creation potential POCP [kg C_2H_4 equivalents] (CML 2001).
- Conformity of LCA with ISO 14040 and 14044 has been approved by a Critical Review
- Assessment of economic and social aspects (LCC and LCWE)

Functional unit / Life Cycle model

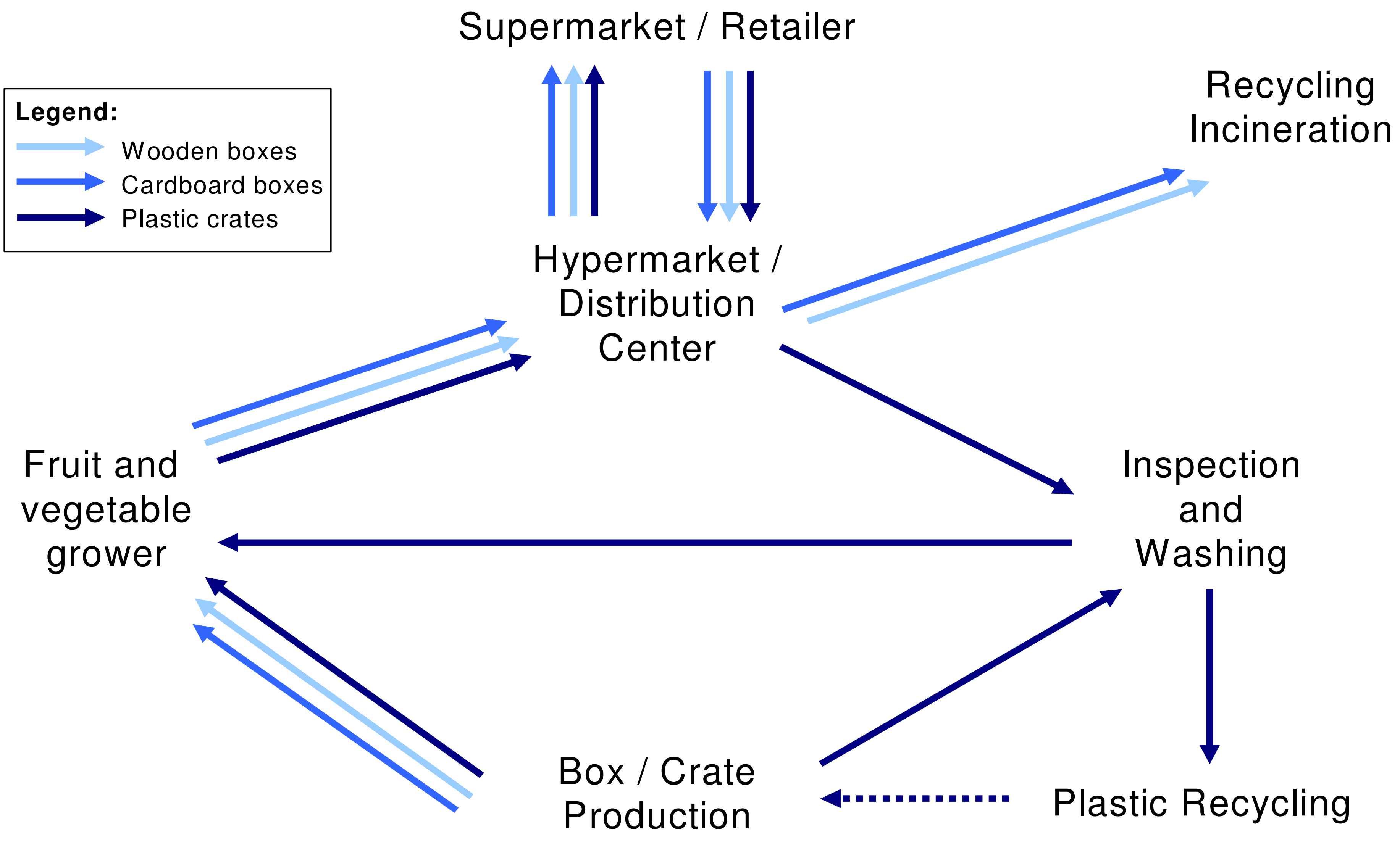
- Functional unit: distribution of 1,000 tons of fruit/vegetables
- Extended functional unit: distribution of 3,333,350 filled boxes/crates



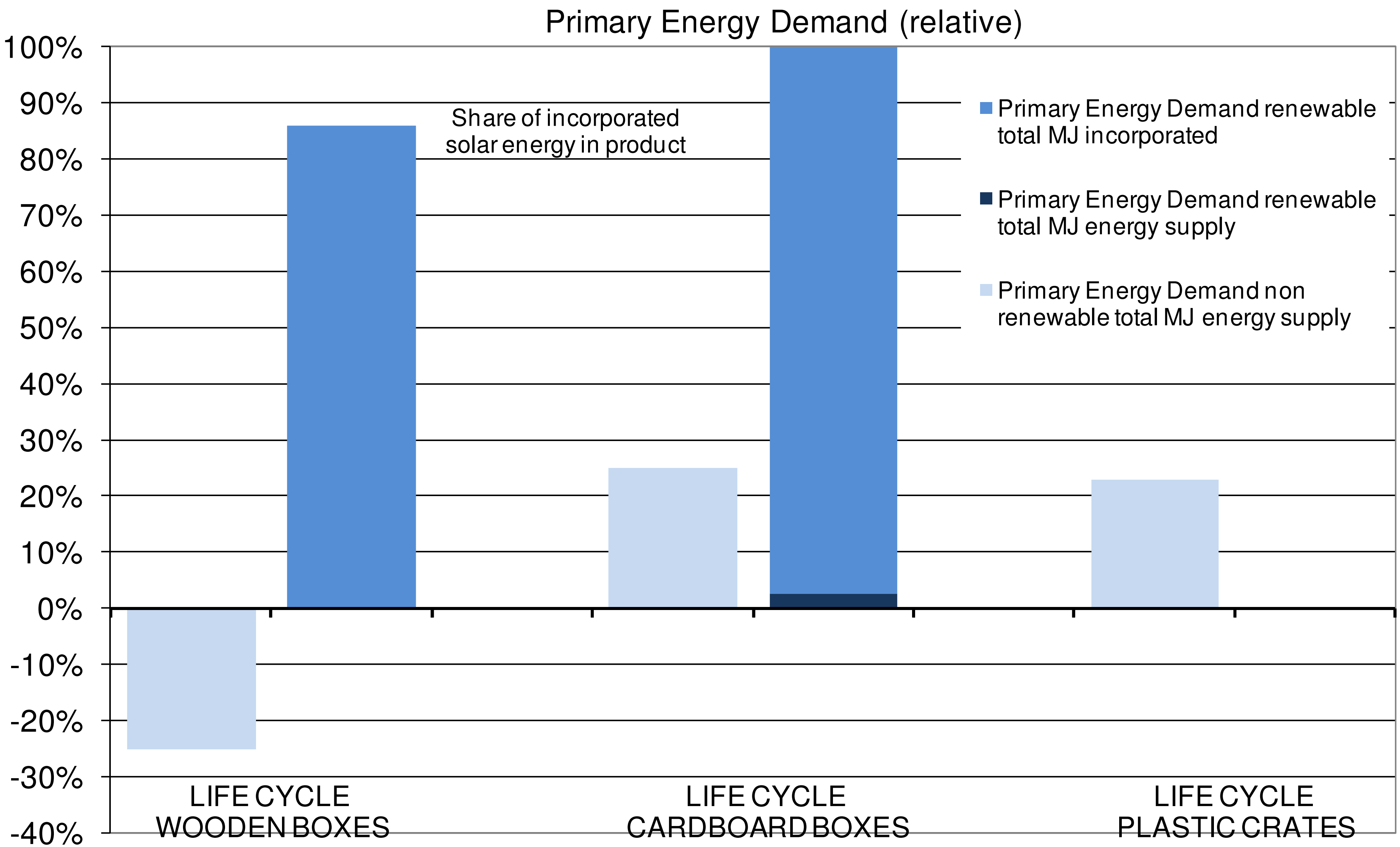
Specifications of boxes / crates

	Wooden boxes	Cardboard boxes	Plastic crates
Production (Material)	Wood	Cardboard	Polypropylene and Polyethylene
Transportation	One way	One way	Multi way
Reuse	-	-	Distribution Cleaning
End-of-Life	Energy recovery Material recycling	Energy recovery Material recycling	Energy recovery Material recycling
Weight of box [kg]	0.9	0.823	2
Dimensions exterior [mm]	600x400x240	600x400x240	600x400x240
Producer countries (fruit & vegetables)	Spain, Italy, France, The Netherlands, Germany		
Consumer countries (fruit & vegetables)	France, The Netherlands, Germany, Great Britain		

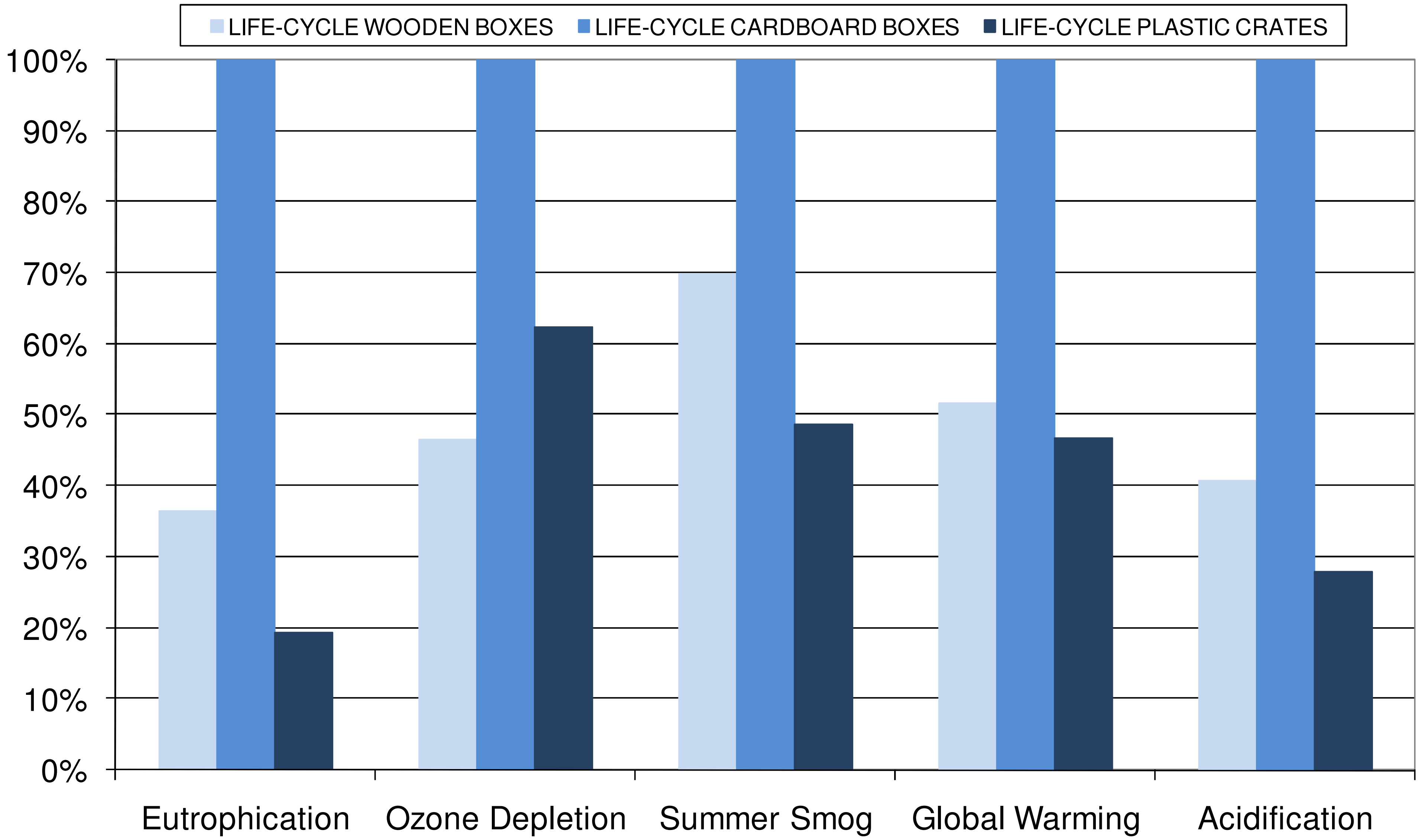
Routes of crates



Primary energy demand (relative)

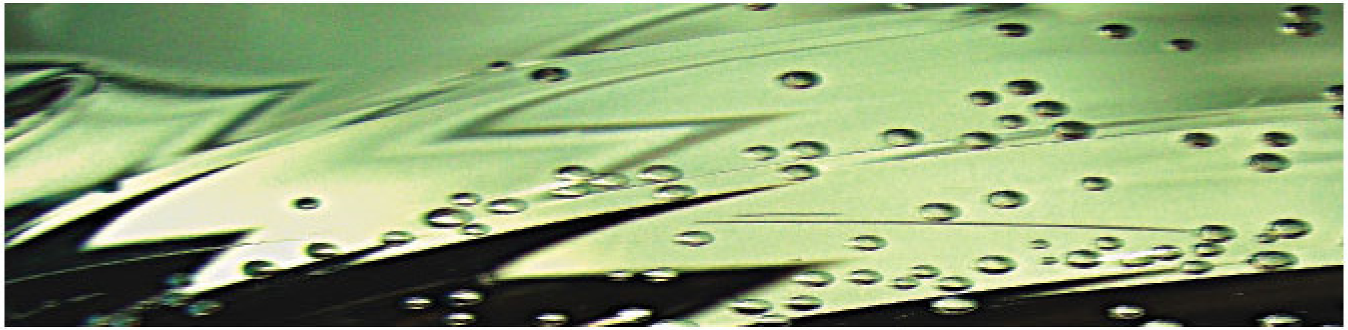


Environmental impacts (relative)

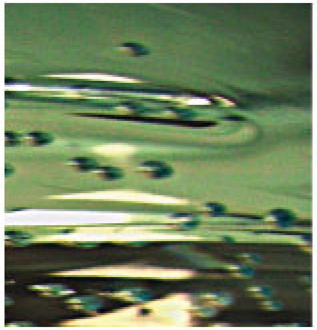


Impact Calculator - Objectives

- Provision of a scientifically basis for non-LCA actors in the packaging industry, logistical service providers and industrial customers to reach decisions on the packaging options that offer the most environmental benefits and that best consider sustainability aspects.
- Illustration of SIM-study results.

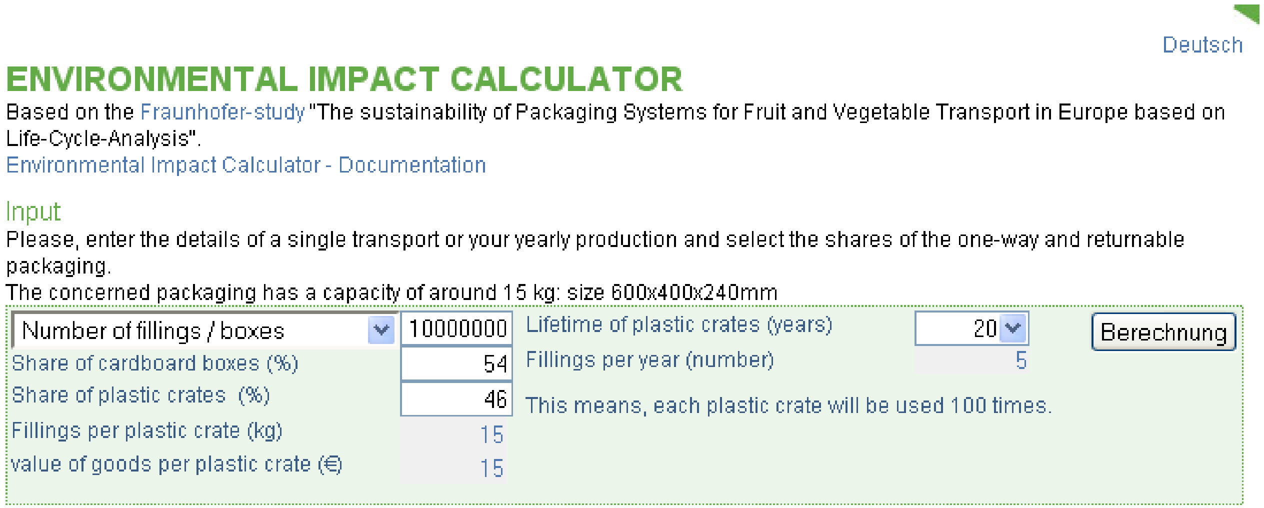


Initiative Mehrweg



Impact Calculator - Inputs

- Selection as to whether the transportation task is to be defined by tonnage [kg], value of goods [€] or number of crates to be transported [number].
- Input of the respective tonnage [kg], value of goods [€] or number of crates to be transported [number] for which the environmental impact is to be calculated.
- Definition of the crate pool composition to be used to complete the transportation task: Input share of one-way (cardboard) or multi-way (plastic) boxes [%].
- Assumed lifetime of plastic crates [years]: in accordance with assumptions made in the study, 10 or 20 years can be selected.



Impact Calculator - Outputs

1. The transportation task defined by the input parameters is initially transformed into the number of transportation events for each cardboard boxes and plastic crates.
2. Scenarios 100% multi-way (plastic) or 100% one-way (cardboard boxes) are calculated using scaling factors as a basis of comparison.
3. Environmental impacts are calculated, taking into account the shares of the different transport options (one-way or multi-way) chosen by the user.
4. Potential savings and already achieved savings are calculated by comparing the results for the chosen transport composition (share of one-way and multi-way) each to 100% multi-way and to 100% one-way.

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Environmental Impacts according to defined pool composition		absolute plastic crate (returnable)	absolute cardboard box (one-way)	Total
Contribution to Greenhouse Effect	kg CO2-Equivalent	1.415.224	3.822.977	5.238.201
Contribution to Overfertilization	kg PO4-Equivalent	1.131	7.065	8.196
Contribution to the Ozone Hole	kg R11-Equivalent	0,492	1,037	1,529
Contribution to Summer Smog	kg C2H4-Equivalent	1.395	3.565	4.960
Contribution to Acid Rain	kg SO2-Equivalent	7.773	34.276	42.049

Savings potential in case of change to 100% plastic crates compared to defined pool composition		relative in %	absolute
Contribution to Greenhouse Effect	kg CO2-Equivalent	41,3 %	2.161.627
Contribution to Overfertilization	kg PO4-Equivalent	70 %	5.737
Contribution to the Ozone Hole	kg R11-Equivalent	30 %	0,459
Contribution to Summer Smog	kg C2H4-Equivalent	38,9 %	1.927
Contribution to Acid Rain	kg SO2-Equivalent	59,8 %	25.151

Impact Calculator - Example

Share of one-way card-board boxes	Share of multi-way plastic crates	Improvement Potential GWP		Improvement Potential EP		Improvement Potential AP	
[%]	[%]	relative to 100% muti-way	absolute [kg CO_2-Eqivalents]	relative to 100% multi-way	absolute [kg PO_4^{3-}-Equivlents]	relative to 100% multi-way	absolute [kg SO_2-Equivlents]
0	**100**	0.0%	0.000E+00	0.0%	0.000E+00	0.0%	0.000E+00
10	**90**	10.2%	3.760E+02	29.5%	1.000E+00	20.5%	5.000E+00
20	**80**	18.5%	7.520E+02	45.5%	2.000E+00	34.0%	9.000E+00
30	**70**	25.4%	1.128E+03	55.6%	3.000E+00	43.6%	1.400E+01
40	**60**	31.2%	1.504E+03	62.6%	4.000E+00	50.8%	1.800E+01
50	**50**	36.2%	1.880E+03	67.6%	5.000E+00	56.3%	2.300E+01
60	**40**	40.5%	2.256E+03	71.5%	6.000E+00	60.7%	2.700E+01
70	**30**	44.2%	2.632E+03	74.5%	7.000E+00	64.3%	3.200E+01
80	**20**	47.5%	3.008E+03	77.0%	8.000E+00	67.3%	3.700E+01
90	**10**	50.5%	3.384E+03	79.0%	1.000E+01	69.9%	4.100E+01
100	**0**	53.1%	3.760E+03	80.7%	1.100E+01	72.1%	4.600E+01

Discussion and Conclusions

- SIM study is a complex model analyzing environmental impacts of different options for fruit and vegetable transport in an European dimension.
- The results of this study (base scenario settings) have been illustrated and made available for the public by transforming them into an easy-to-handle web tool.
- The tool provides only a few specification possibilities for the user.
- Nevertheless, it can be employed for information and decision-making support in the fruit and vegetable packaging and transport industry, for example for the compilation of pools for transport boxes; thus contributing to the sustainability of this sector.

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- **How to reach the next level of sustainability**
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