POLITECNICO DI MILANO

Packaging re-use in the circular economy: an LCA evaluation

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Assessment on WAste and REsources

THE CONTEXT

- in the Circular Economy Package, one of the proposed actions is to increase the preparing for **re-use** and recycling targets for packaging waste
- reliable information and data about **re-use** and specifically about reusable packaging in Europe is lacking

In order to address such a gap, CONAI (the National Packaging Consortium in Italy) has been supporting a comprehensive study about the practice of packaging re-use in Italy

Journal of Material Cycles and Waste Management (2019) 21:35–43
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SPECIAL FEATURE: ORIGINAL ARTICLE

The 4th International Conference on Final Sinks (4th ICFS 2017)

Packaging re-use: a starting point for its quantification

Lucia Rigamonti[1] · Laura Biganzoli[1] · Mario Grosso[1]

AIM OF THE STUDY

Understanding the environmental impacts of the practice of packaging re-use

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Life Cycle Assessment (LCA) methodology applied to evaluate the environmental performance of the life cycle of reusable packages:

1. to identify the contribution of the reconditioning process to the total impacts of the life cycle
2. to understand how the impacts change with the number of uses (i.e. rotations)

TYPES OF PACKAGING

Available online at www.sciencedirect.com

ScienceDirect

ELSEVIER

Procedia CIRP 69 (2018) 827 – 832

www.elsevier.com/locate/procedia

25th CIRP Life Cycle Engineering (LCE) Conference, 30 April – 2 May 2018, Copenhagen, Denmark

Intermediate bulk containers re-use in the circular economy: an LCA evaluation

IBCs

Laura Biganzoli*, Lucia Rigamonti, Mario Grosso

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Journal of Material Cycles and Waste Management (2019) 21:67–78
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SPECIAL FEATURE: ORIGINAL ARTICLE

The 4th International Conference on Final Sinks (4th ICFS 2017)

LCA evaluation of packaging re-use: the steel drums case study

Laura Biganzoli[1] · Lucia Rigamonti[1] · Mario Grosso[1]

resources

MDPI

Article

Life Cycle Assessment of Reusable Plastic Crates (RPCs)

Camilla Tua, Laura Biganzoli, Mario Grosso and Lucia Rigamonti *

Resources 2019, *8*, 110; doi:10.3390/resources8020110

DATA COLLECTION

Visit of plants situated in the North of Italy + questionnaires

to gather primary information on the **reconditioning process** required before re-use

↓

the layout and the mass balance of an average reconditioning plant for IBCs, for steel drums and for RPCs were defined

↓

LCA study

(12 impact categories according to the Product Environmental Footprint (PEF) guide + water consumption + Cumulative Energy Demand)

Geographical and temporal boundaries: Northern Italian context - reference year: 2015 for IBCs and steel drums, and 2016-2017 for RPCs

CHARACTERISTICS OF THE PACKAGING

IBC	Steel (kg)	Plastic (kg)	Wood (kg)
with wood pallet	22 (cage)	16 (bottle)	23 (pallet)
with plastic pallet	22 (cage)	35 (bottle 16, pallet 19)	-
with steel pallet	42 (cage 22, pallet 20)	16 (bottle)	-

1.49 kg each, polypropylene
(single use crate: 579 g)

15.7 kg each, steel

FUNCTIONAL UNIT

function of the system (IBCs): to provide a user with 100 IBCs for a number of uses n included between 1 and 5

n = 1 → the new manufactured IBCs are used only once and then sent to recycling/disposal

n = 2 → the new manufactured IBCs, after the first use, are sent to a reconditioning plant. Here, 24% of the IBCs cannot be reconditioned and are sent to recycling/disposal, i.e. such 24% must be replaced by new manufactured IBCs to have 100 IBCs ready for the second use

And so on

functional unit (FU) (IBCs): 100 IBCs ready to be used *n* times, with n included between 1 and 5

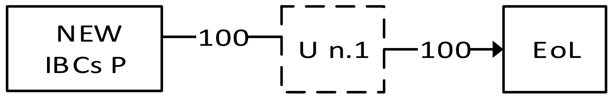
FU (steel drums): 100 steel drums ready to be used *n* times, with n included between 1 and 10

FU (RPCs): 1200 kg (corresponding to 100 RPCs) of carrying capacity at each delivery. The number of deliveries (n) is included between 1 and 125

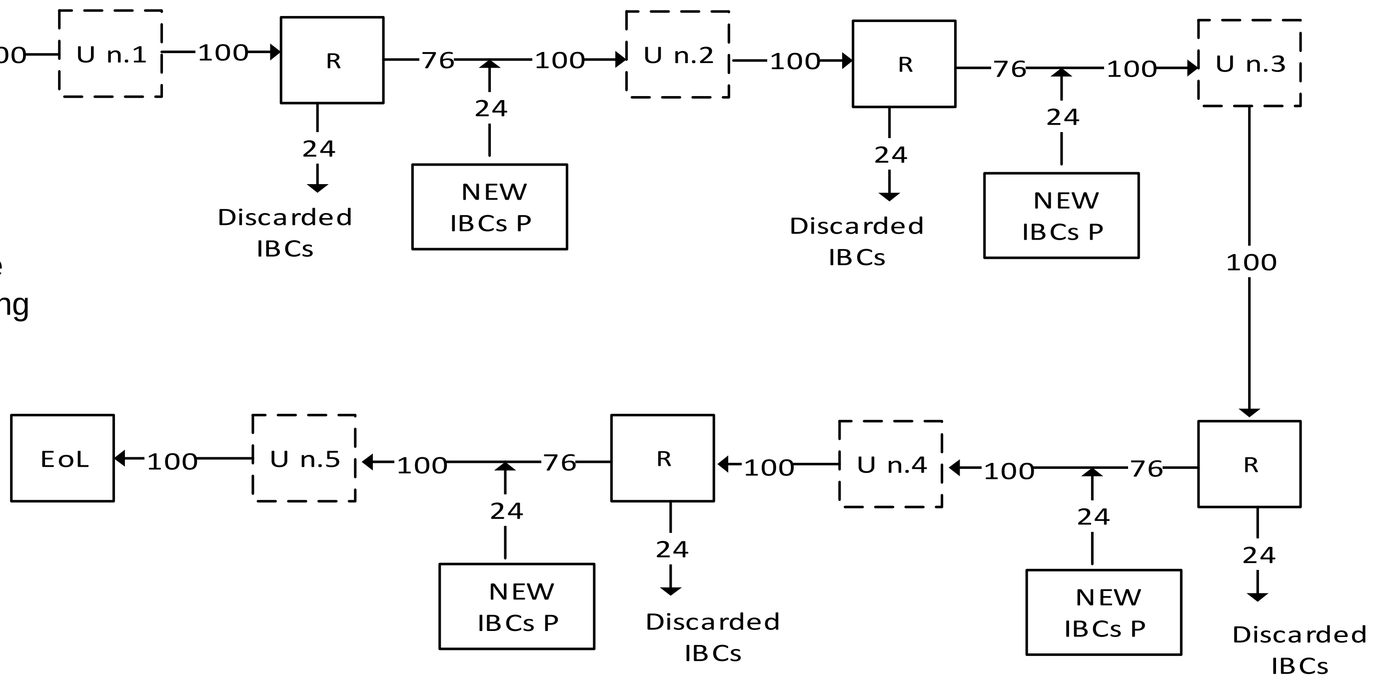
SYSTEM BOUNDARIES

Simplified chart of the life cycle of 100 IBCs as the number of rotation changes:

n=1



2 ≤ n ≤5



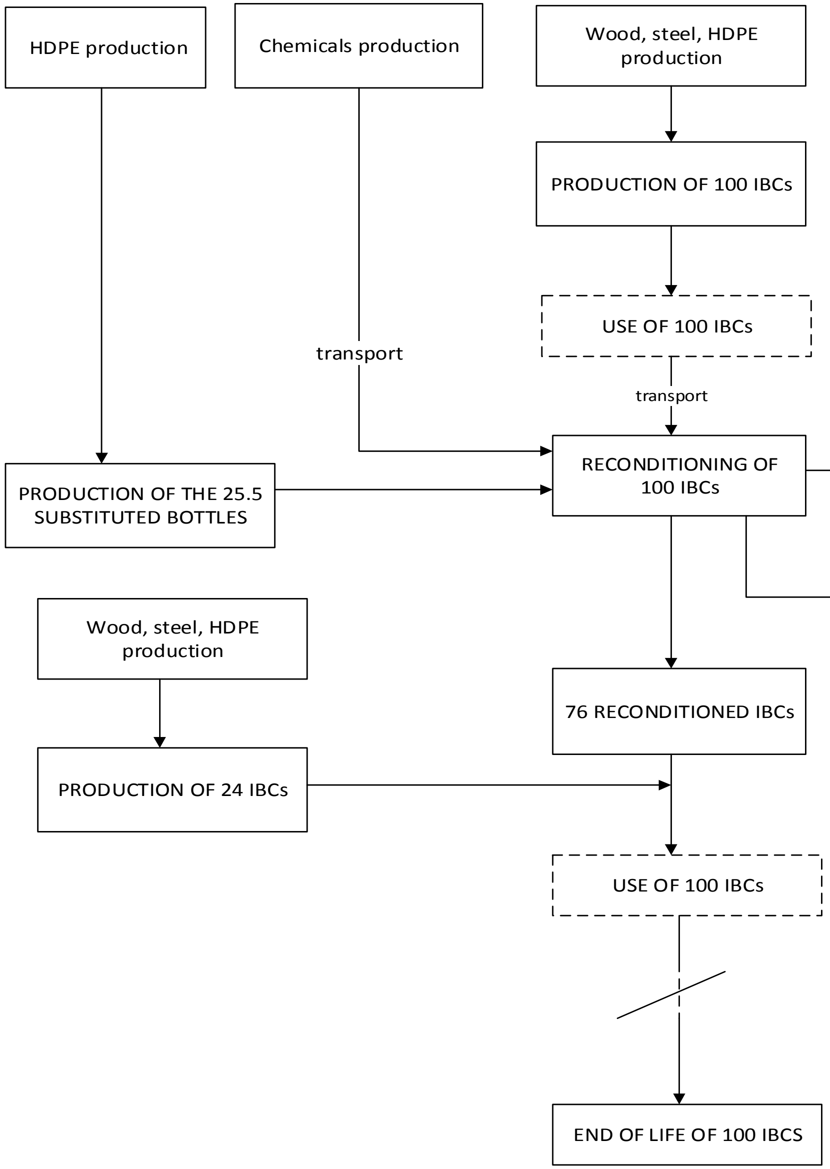
P= production
U= use
EoL= end of life
R= reconditioning

CASE STUDY OF IBCs

The life cycle of 100 IBCs ready to be used n times includes:

- the production of [100+24*(n-1)] IBCs
- the reconditioning of 100*(n-1) IBCs
- the end-of-life of [100 +24*(n-1)] IBCs

SYSTEM BOUNDARIES



CASE STUDY OF IBCs

Cases of multi-functionality were solved by expanding the system boundaries to include avoided productions due to material and energy recovery from waste

- At the plant, 24% of IBCs cannot be reconditioned because too damaged
- The remaining 76% are washed by using hot pressurized water and a mix of chemical products. After washing, IBCs are further checked: on average, 33.6% of the washed bottles are discarded

LCA OF RE-USE OF IBCs: CONCLUSIONS AND RECOMMENDATIONS

- The contribution of the reconditioning process to the overall impacts increases with the number of uses (1-5), but it is in any case modest and below 20% for most of the considered impact indicators

- The main burdens of the reconditioning process are associated with:
  - the handling of the discarded bottles (disposal of the solid residues and production of the new bottles) → very important the behaviour of the users that should remove any chemical residues from the bottles before sending the IBCs to reconditioning
  - the transport of the IBCs to the reconditioning plant → widespread distribution of the reconditioning plants in the national territory

- Reconditioning and reusing IBCs is preferable to a situation where they are used only once and then sent to recycling/disposal: the environmental burdens of a system based on re-use are about 62-76% of those of a system based on the single use if n=2, 49-69% if n=3, 43-64% if n=4, 39-62% if n=5, depending of the considered impact category (i.e. the benefits associated with the practice of re-use increase with the number of rotations)

LCA OF RE-USE OF STEEL DRUMS: CONCLUSIONS AND RECOMMENDATIONS

- The contribution of the reconditioning process to the overall impacts increases with the number of uses (1-10), but it is in any case modest and below 20% for most of the considered impact indicators

- The main burdens of the reconditioning process are associated with:
  - the transport of the drums to the reconditioning plant → widespread distribution of the reconditioning plants in the national territory
  - the disposal of the residues removed from the drums → the behavior of the users is very important, who should use all the content of the drums before sending them to reconditioning
  - the cleaning process (energy and solvent consumption)

- Reconditioning and reusing steel drums is preferable to a situation where they are used only once and then sent to recycling: the environmental burdens of a system based on re-use are about 74% of those of a system based on the single use if n=2, 65% if n=3, […..], 53% if n=10 (i.e. the benefits associated with the practice of re-use increase with the number of rotations)

LCA OF RE-USE OF RPCs: CONCLUSIONS AND RECOMMENDATIONS

- For a low number of rotations (e.g. n=20), the burdens are mainly associated to the production stage (52%-85% depending on the indicator). By increasing the number of rotations, larger contribution of the reconditioning stage (e.g. 29-71% for 100 deliveries)

- The main burdens of the reconditioning process are associated with:
  - the transport of the RPCs to the reconditioning plant → widespread distribution of the reconditioning plants in the national territory
  - the electricity consumption of the reconditioning plant →reducing energy consumptions and promoting the use of alternative/renewable energy sources

- On average, the burdens of the RPCs system are 2.6 (n=1) and 1.3 (n=2) times higher than those related to the single use plastic crates system. Starting from three deliveries, the results rapidly change in favor of the RPCs system, i.e. reconditioning and re-use of crates is preferable than single use and recycling (e.g. environmental impacts of the RPCs system: 54%-60% of those of the single use plastic crates if n = 5, 6%-13% if n = 125)

THANK YOU FOR YOUR ATTENTION!

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