JOHANNES KEPLER
UNIVERSITY LINZ

Open Innovation Nachhaltigkeit: Kreislaufwirtschaft & Materialinnovation

10.6.2021, WKO Oberösterreich, Offen für Innovation

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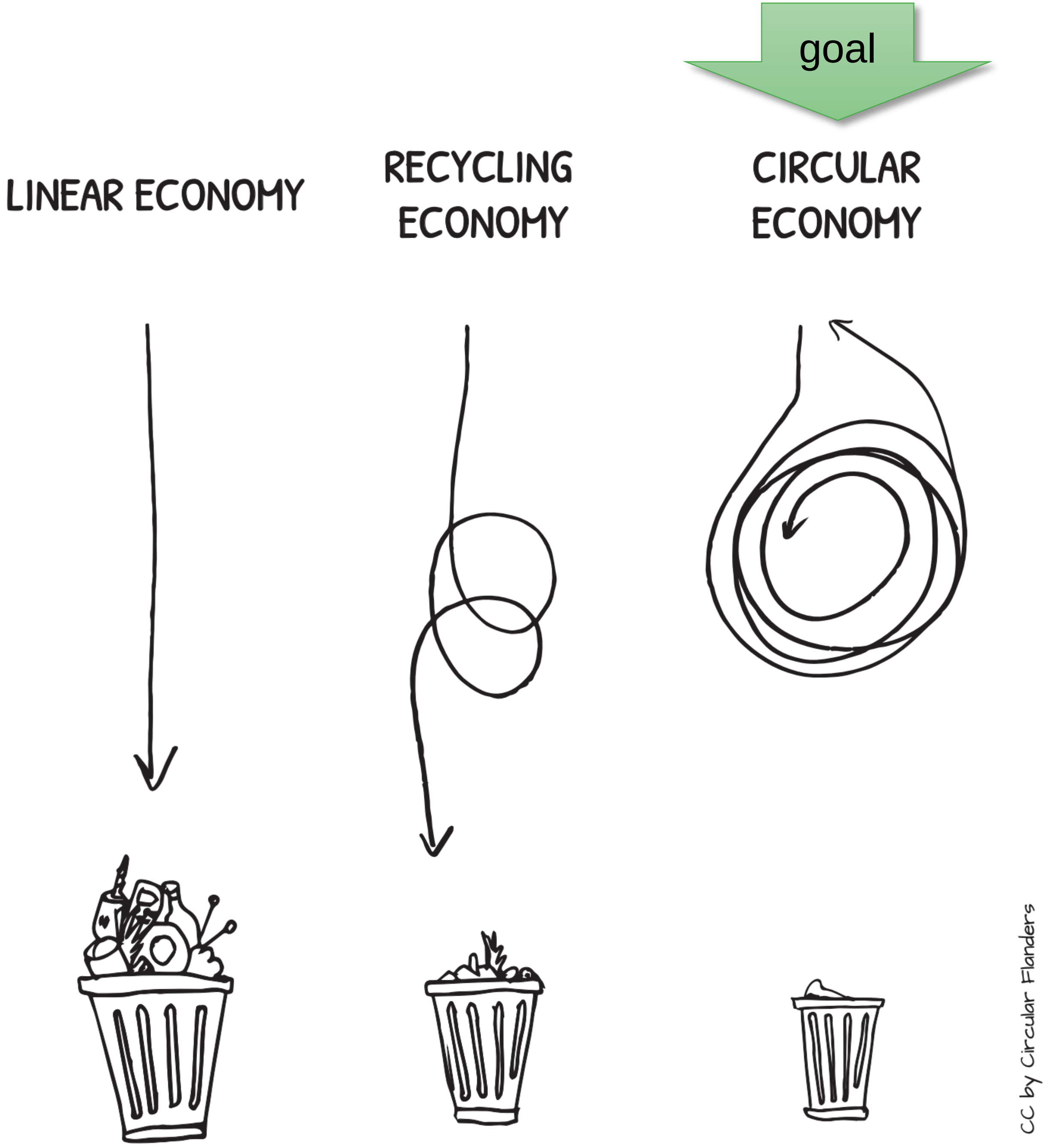
Source: http://eitrawmaterials.eu/ (11.4.2016)

United Nations ‘State of the Planet’ speech

- Humanity is waging war on nature.
- This is suicidal.
- Nature always strikes back and is doing so with gathering force and fury.

(Antonio Guterres, UN Secretary-General, 2. December, 2020)

Source: https://www.un.org/sg/en/content/sg/speeches/2020-12-02/address-columbia-university-the-state-of-the-planet (14.12.2020)


goal
LINEAR ECONOMY
RECYCLING ECONOMY
CIRCULAR ECONOMY
CC by Circular Flanders

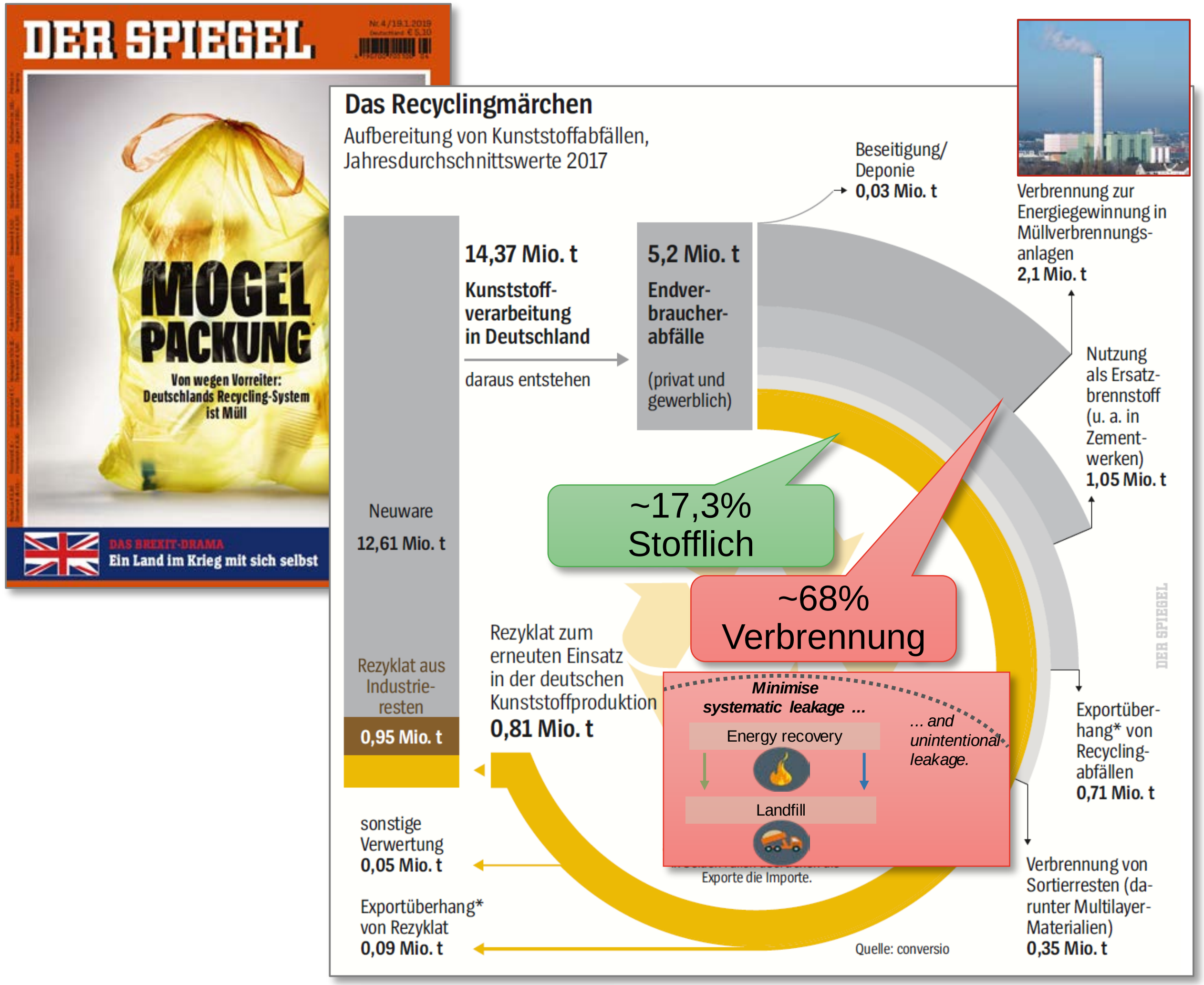
AGENDA

1. Challenges and motivation
2. Today's downcycling economy
3. Principles of a (real) circular economy
4. Collaboration becomes key to innovation in the area of ...

   ... circular product redesign

   ... circular service operations (=reverse flows)
5. Conclusion

Recycling champions – or only collection champions?



Quelle: Bethge, P., Bruhns, A., Klawitter, N., & Salden, S. (2019, January 19). Der dreckige Rest. DER SPIEGEL, pp. 10–18.

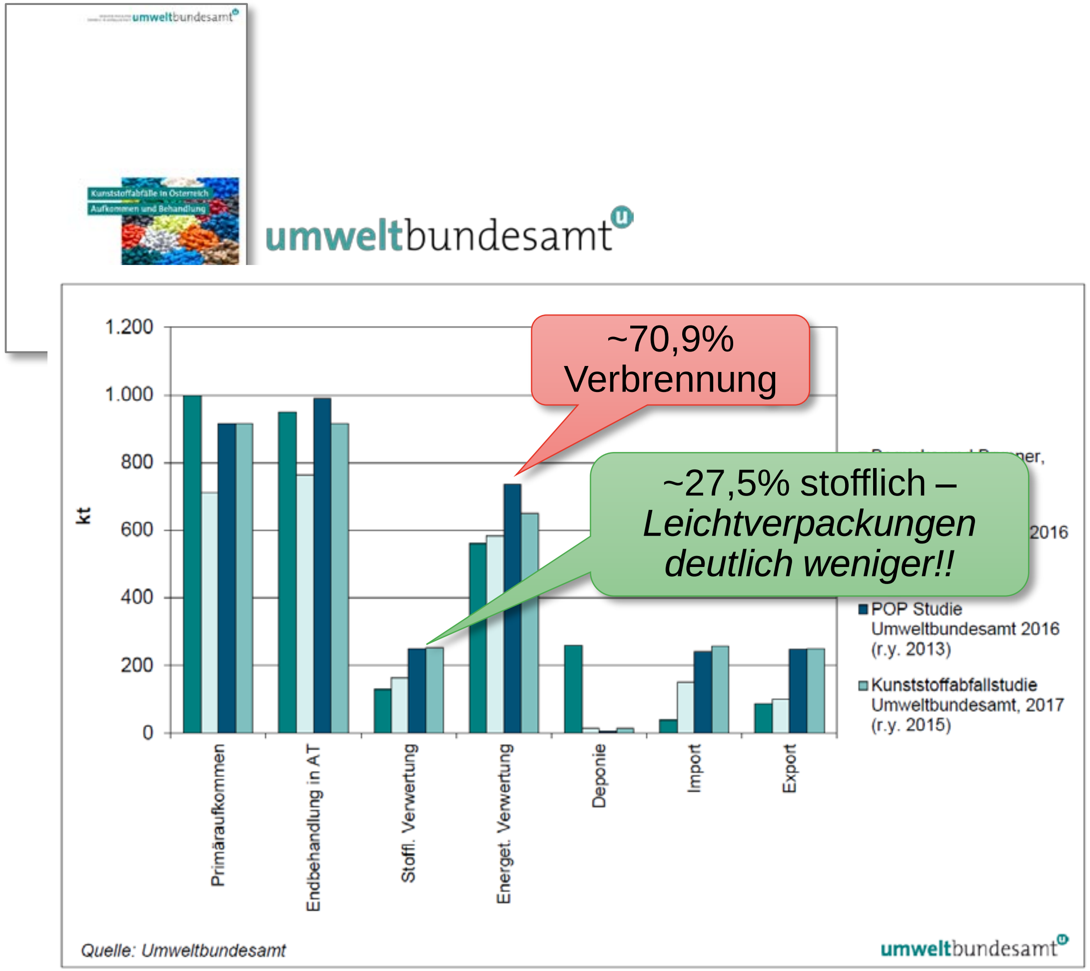


Abbildung 14: Vergleich mit früheren Studien – „Zeitreihe Kunststoffabfälle" (Referenzjahre gem. Tabelle 8 in kt).

Quelle: Stoifl, B. (2017). Kunststoffabfälle in Österreich: Aufkommen & Behandlung : Materialien zum Bundes-Abfallwirtschaftsplan 2017. Report / Umweltbundesamt: REP-0650. Wien. Retrieved from https://www.bmnt.gv.at/umwelt/kunststoffe/Kunststoffabf-lle-in--sterreich---Aufkommen--Behandlung-und-Recycling.html (accessed: 6.5.2019).

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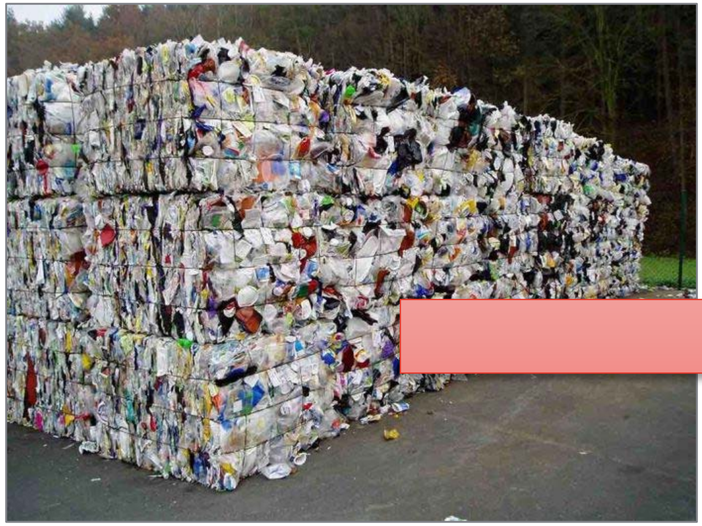
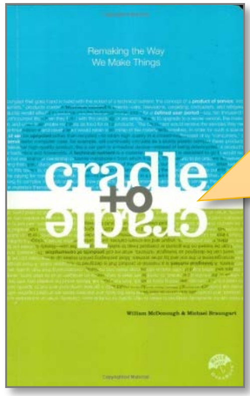
Too often ‘Downcycling’, if at all



Ballen von Kunststoff-Verpackungen (Foto: ©Petra Hoeß, FABION Markt + Medien / abfallbild.de)

Quelle: Hansen



*“A **technical nutrient**, on the other hand, may be defined as a material …*
*that has the potential to **remain safely in a closed-loop system***
of manufacture, recovery, and reuse …,
***<u>maintaining its highest value</u> through <u>many</u> product life cycles.**”*

(Braungart & McDonough 2007, p.1343)

Substances of concern in materials as barriers to (re)cycling

Paper

BfR
Bundesinstitut für Risikobewertung

befinden sich hier: **Lebensmittelverpackungen aus Recyclingmaterialien müssen sicher sein**

15/2010, 03.11.2010

Neuntes BfR-Forum Verbraucherschutz beschäftigt sich mit gesundheitlichen Risiken durch Recycling-Verpackungen

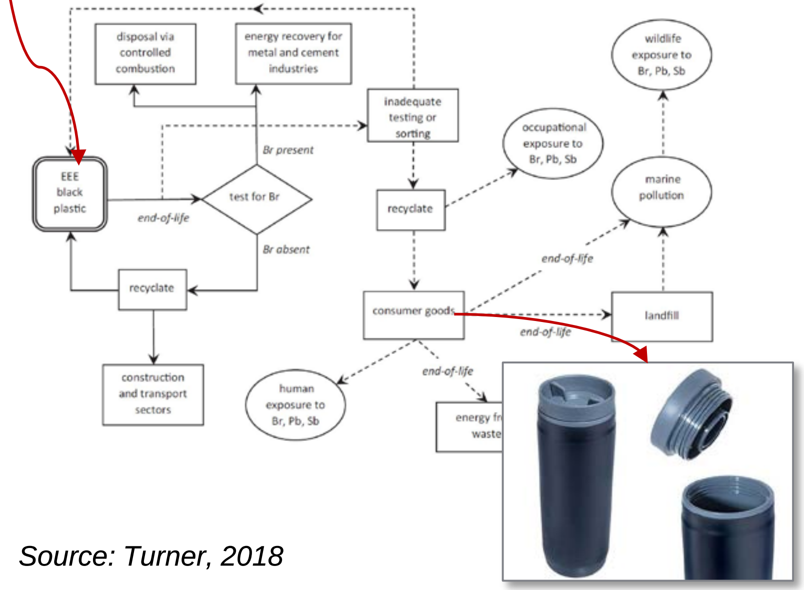
CORNFLAKES

	Kellogg's Corn Flakes	Pétales de maïs sucrés (Carrefour)	Chabrior Corn Flakes (Intermarché)
Mindesthaltbarkeitsdatum	13/05/2016	21/02/2016	07/05/2016
Verpackungsmaterial**	Recyclingfaser	Recyclingfaser	Recyclingfaser
IN DER VERPACKUNG			
Gesättigte Mineralöle (MOSH) in mg/kg	257	409	383
Aromatische Mineralöle (MOAH) in mg/kg	41	159	128
IM LEBENSMITTEL			
Gesättigte Mineralöle (MOSH) in mg/kg	0,6	1,6	3,3
Aromatische Mineralöle (MOAH) in mg/kg	nicht nachweisbar	0,4	0,9

**Annahme basierend auf den in der Verpackung gefunden Mengen an MOSH und MOAH (bei weniger als 175mg/kg MOSH u oder nur äußerst geringem Nachweis von MOAH in der Verpackung wird angenommen, dass diese aus Frischfasern besteht).

Source: Foodwatch e.V., 2015

Plastics



Source: Turner, 2018

Electronics

“all the stages and processes involved [at the recycling plant] are affected by worrying levels of pollutants, especially mercury vapors”

(Source: Zimmermann et al. 2014)

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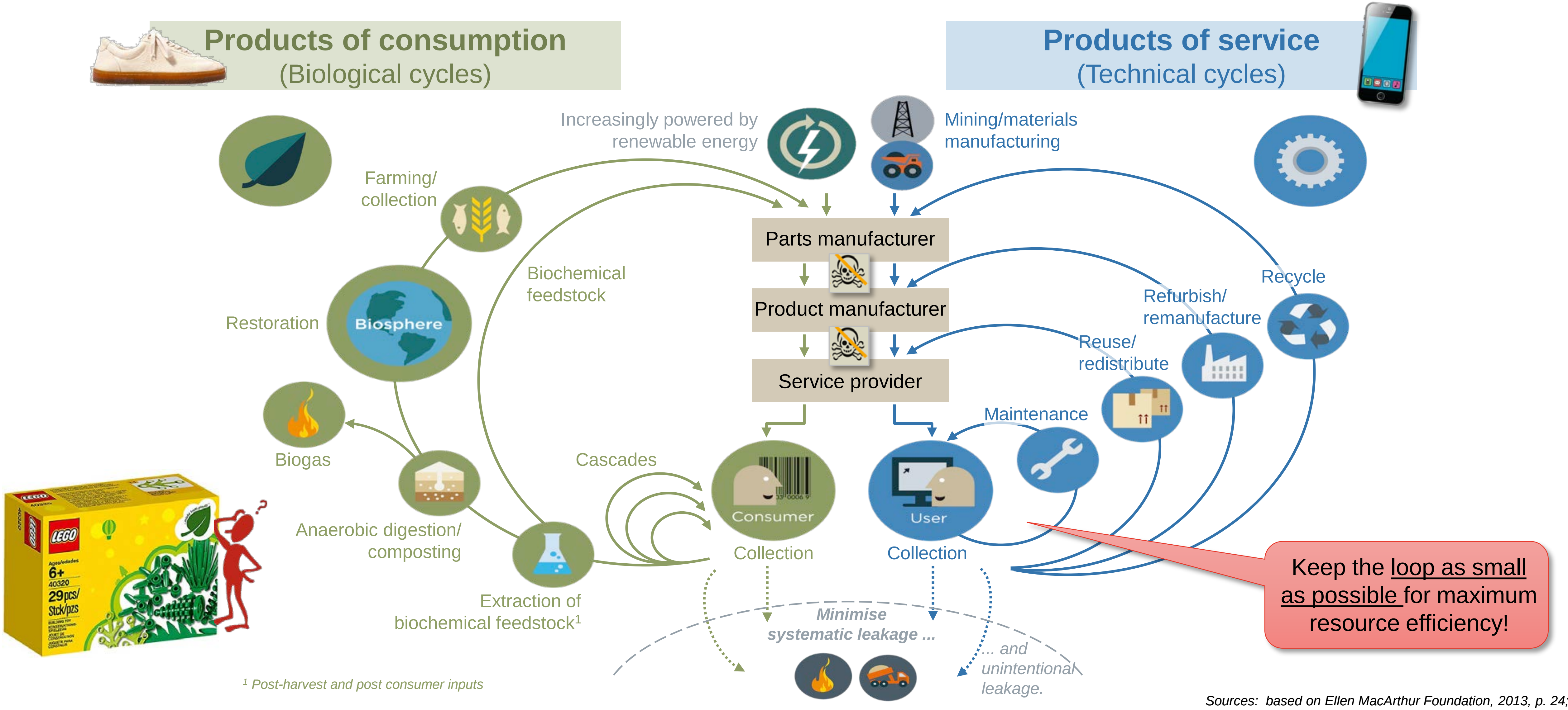
Circular Economy framework: from linear to circular



¹ Post-harvest and post consumer inputs

Sources: *based on Ellen MacArthur Foundation, 2013, p. 24; Braungart & McDonough, 2009*
Image "shoe": https://www.nativeshoes.com/

Excursus

Biogenic resources are not a panacea: at scale, they usually cause significant sustainability problems themselves

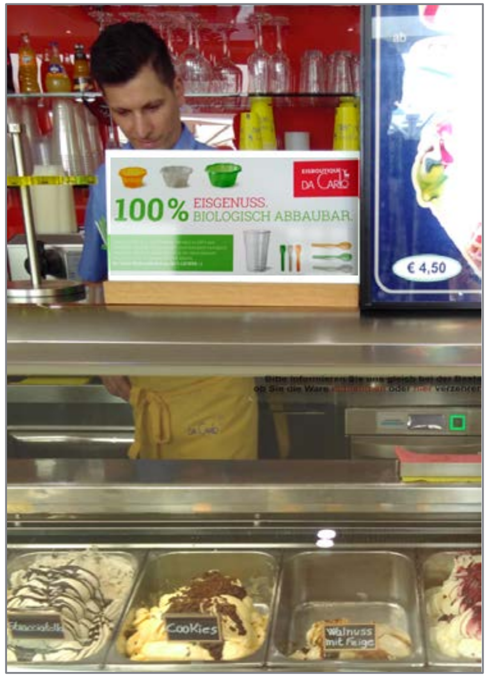


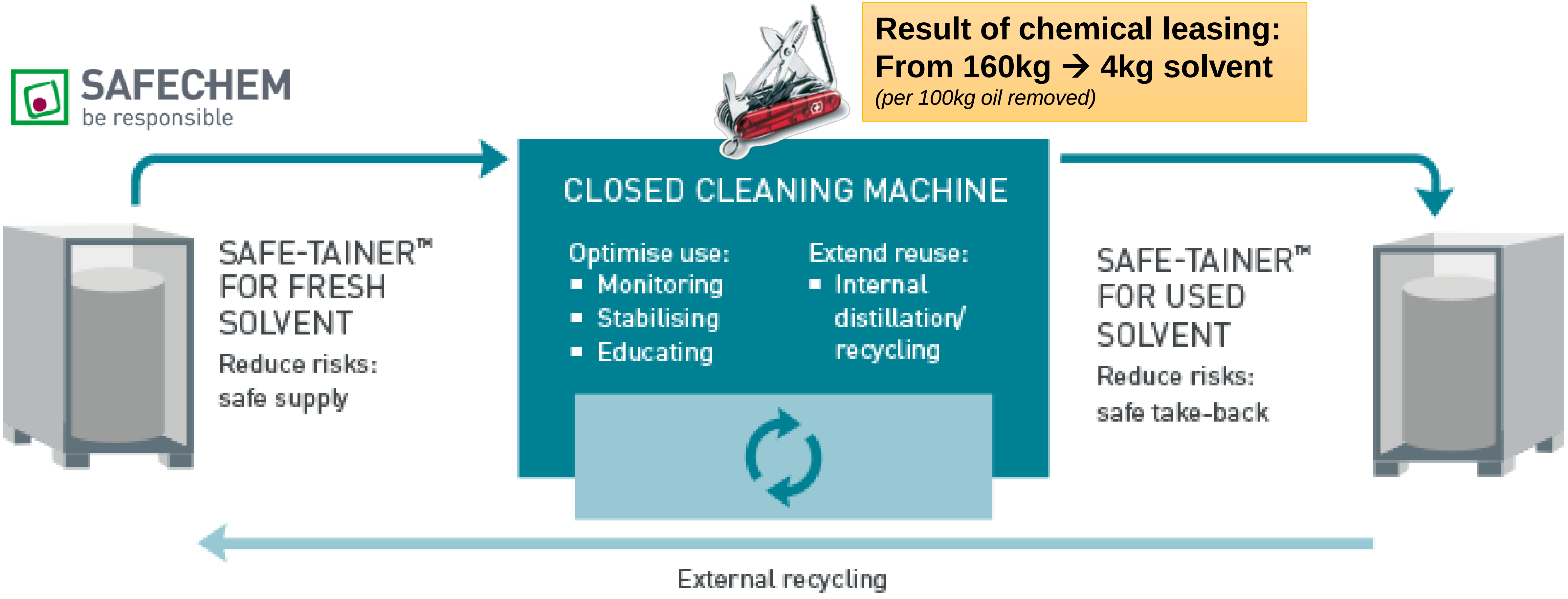
Photo: Hansen, 2019

- Übersimplifizierte (Fehl-)Annahme der „CO_2-Neutralität“ von bio-basierten Rohstoffen
- CO_2 Vorteil = Nachteil in anderen Umweltdimensionen
  - Agroindustrielle Landwirtschaft (Dünger, Pestizide)
  - Nahrungsmittelkonflikte
  - Förderung von Monokulturen
- Begrenzte Flächen für Landwirtschaft
  - Indirekte Landnutzungsänderungen (ILUC) meist unberücksichtigt (Weiss et al. 2012)
  - z.B. Zuckerrohranbau in Brasilien → Regenwaldabholzung
- Relevanz fraglich:
  - Nur 5% fossiler Energie (Öl, Gas) geht in stoffliche Verwendung (Deutschland, VCI, 2018)
  - Recycling führt zu Wiederverwendung

Critical evaluation when and where the targeted use of bio plastic makes sense (vgl. EC, 2018)

Loop 1a: Maintenance and reuse –
the case of quality chemicals via “chemical leasing”

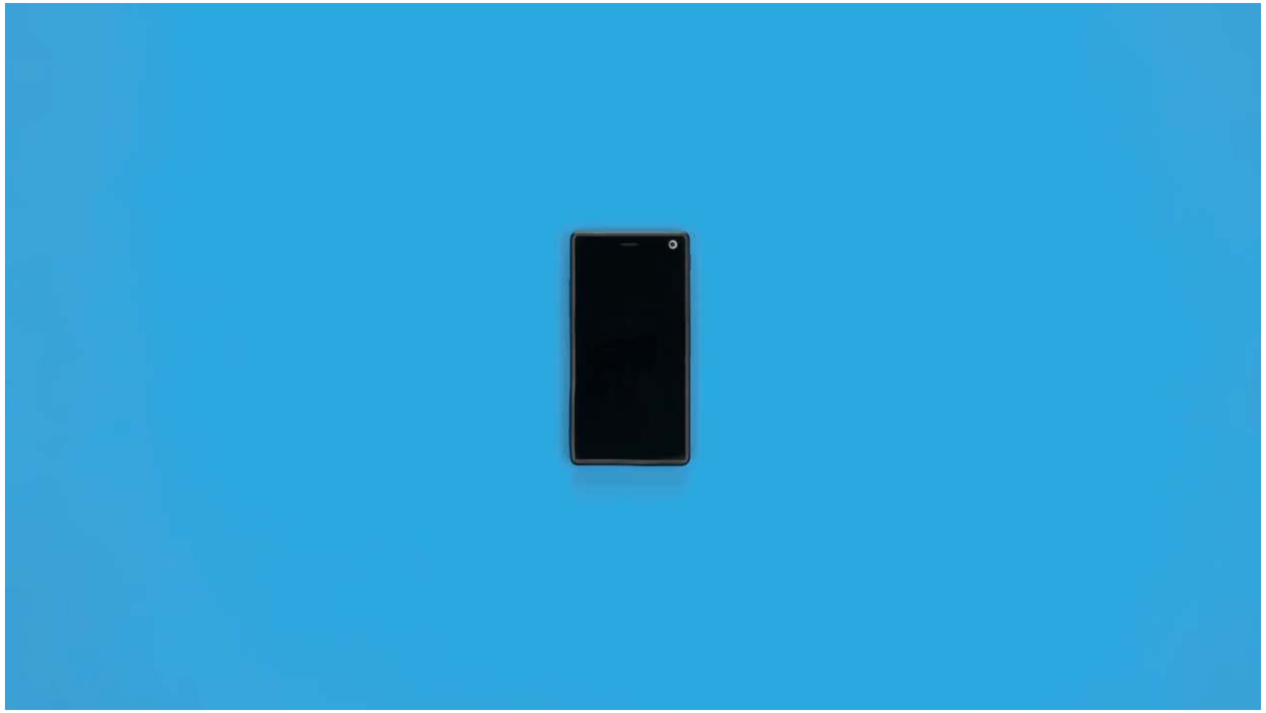
Result of chemical leasing:
From 160kg → 4kg solvent
(per 100kg oil removed)



Source: http://www.safechem.com/en/metal-cleaning/compleasetm.html (5.11.2018)

Loop 1b: Repair

Image sources: https://www.fairphone.com/2015/11/18/guest-blog-ifixit-on-fairphone-2-the-first-truly-smart-smartphone/ (14.12.2015)



https://www.youtube.com/watch?v=6DW733G76BY (10.04.2016); 0:37

Guest Blog: iFixit and Fairphone Repair Guides

IFIXIT + FAIRPHONE

Loop 2: Reuse & redistribute

We're opening Worn Wear **used clothing sections** in several of our stores. .. It's part of our Common Threads Partnership with our customers **to reduce consumption, repair what breaks, recirculate what we no longer use** ...

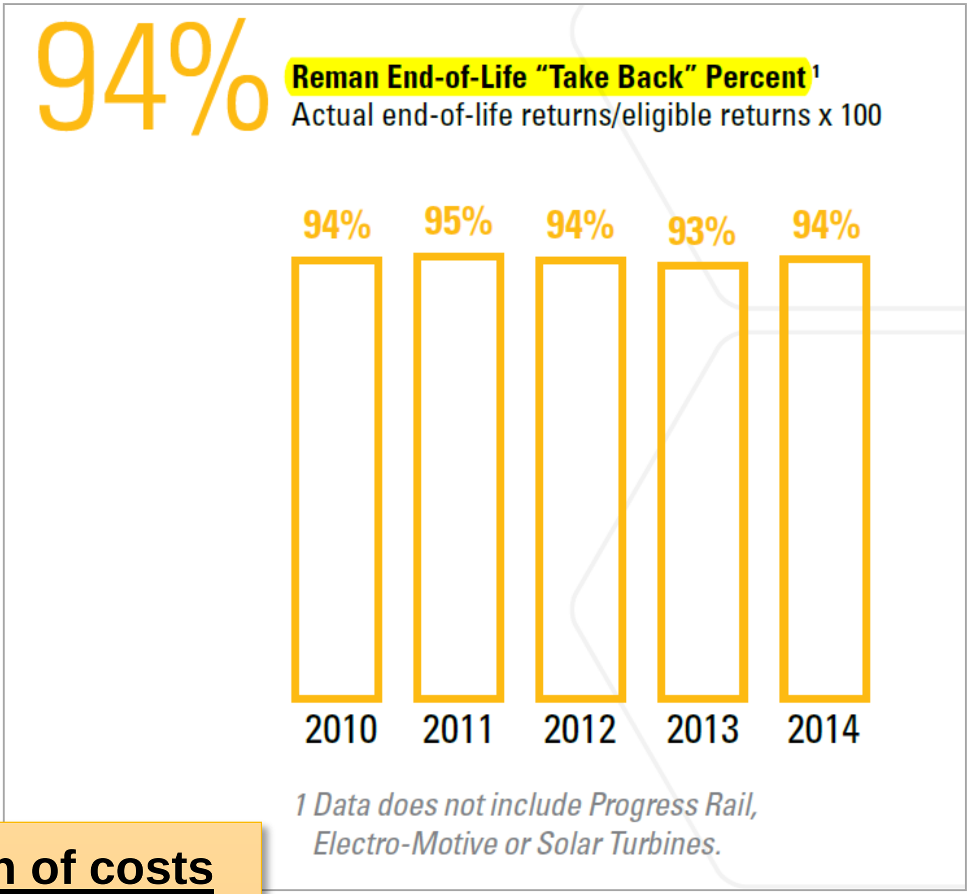
patagonia®

Loop 3: Remanufacturing (incl. upgrading)

REMANUFACTURED PRODUCTS AND REBUILT PRODUCTS

Caterpillar encourages sustainable business practices through our remanufacturing and rebuild businesses. This starts with durable products, many designed to be rebuilt multiple times. Through our reman and rebuild programs, components and machines are overhauled, rather than completely replaced. Reuse of parts reduces waste and minimizes the need for the raw materials necessary to produce new parts. This system is where Caterpillar is making some of its greatest contributions to sustainable development – keeping nonrenewable resources in circulation for multiple life cycles.

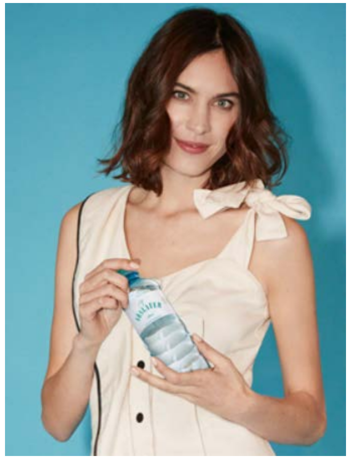
Our reman parts and components program provides customers an exchange system where they can return an end-of-life component (called "core") for a remanufactured replacement. For more than 40 years, Caterpillar's remanufactured products have provided same-as-new ...ance, reliability and warranty at fraction-of-new costs, as ...ell as availability that gives customers more options at repair and



Source: Caterpillar (2015) Sustainability Report 2014, p.47

- **"Same-as-new"** performance, reliability and warranty **at fraction of costs**
- **Durable products** as the basis
- **Designed to be rebuilt** multiple times
- Components/machines are **overhauled rather than replaced**
- **Technology upgrading** of decisive components
- Provision of **exchange system** where customers return end-of-life products

Loop 4: Closed-loop (mechanical) recycling



EGGER GETRÄNKE

RAUCH

Spitz

VÖSLAUER

Coca-Cola HBC Österreich

Source: http://www.pet2pet.at (14.12.2020)

Circular economy: New standards and product labels (selection)

Kreislauf-Strategie im Produkt-design

Zirkuläres Produkt- und Dienstleistungsdesign

Basierend auf definierten Materialien, Schadstoffeleminierung und reduzierter Material/Teile-Vielfalt

1. **Produktintegrität** *(Produkte & Komponenten)*
   - Lange Nutzung
     - Technische Haltbarkeit
     - Emotionale Haltbarkeit
   - Verlängerte Lebensdauer
     - Wartbarkeit & Wartung
     - Upgrade-fähigkeit & Upgrades
   - Wiederherstellung
     - Reparatur-fähigkeit & Reparatur
     - Refurbishment/ Remanufacture
2. **Recycling** *(Materialien)*
   - für Recycling
     - schadstofffrei, Monomaterialien
   - von Recycling
     - Recyclat-einsatz
3. **Biologische Kreisläufe** *(Materialien)*
   - für natürliche Kreisläufe
     - Biologisch abbaubar
   - von natürlichen Kreisläufen
     - Biobasierte Materialien

© IQD

Prozess / Organisa-tions Standards

CEN CENELEC

ANSI RIC001.1-2016

ISO TECHNICAL COMMITTEES ISO/TC 323 Circular economy

ICS > 03 > 03.100 > 03.100.70
ISO/FDIS 14009
Environmental management systems — Guidelines for incorporating material circulation in design and development

EN4555x

Produkt Labels (zertifizierbar)

HTV Life ; CERTIFIED NCERT »ausgezeichnet« reparaturfreundlich & langlebig

eSync ALLIANCE

LABEL PRODUIT RECONDITIONNÉ

100% ; RecyClass

RAL GÜTEZEICHEN RECYCLING-KUNSTSTOFF ; FSC RECYCLED

OK compost TÜV AUSTRIA INDUSTRIAL ; OK biodegradable TÜV AUSTRIA WATER

USDA CERTIFIED BIOBASED PRODUCT

CERTIFIED cradletocradle GOLD

Source: Hansen, E. G., Revellio, F., Schmitt, J., Schrack, D., Alcayaga, A., & Dick, A. (2020). Circular Econ erfolgreich umsetzen: die Rolle von Innovation, Qualitätsstandards & Digitalisierung (Quality Austria Whitep Vienna. Retrieved from www.qualityaustria.com (accessed: 30.9.2020).

Goals of and necessary capabilities in the Circular Economy

Circular Economy is a global economic model
that decouples economic growth and development
from the consumption of finite resources.

Source: Webster 2015, p.16

- replaces the ‘end-of-life’ concept with **restoration**,
- shifts towards the use of **renewable energy**,
- eliminates the use of **toxic chemicals**, which impair reuse, and
- aims for the **elimination of waste**

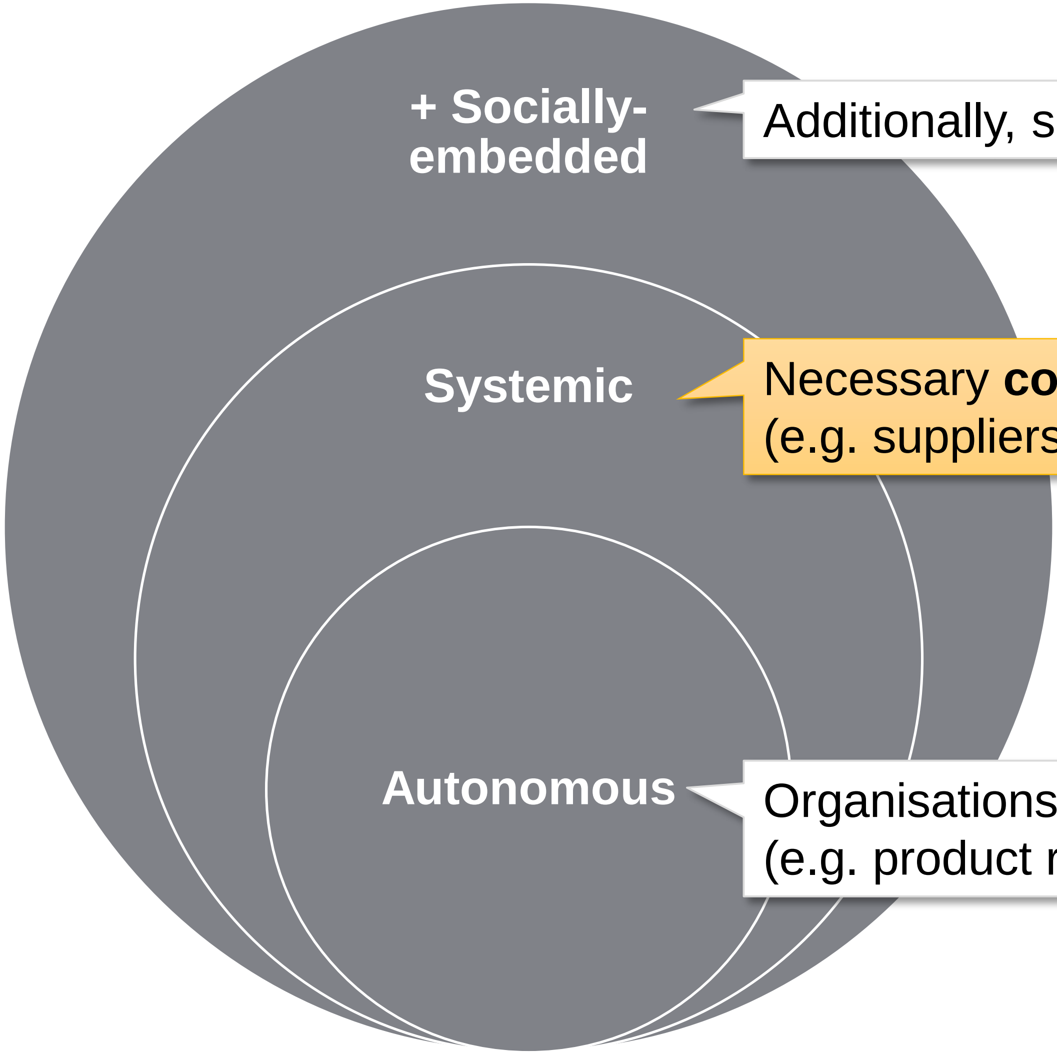
Source: Ellen MacArthur Foundation (EMF). (2013). Towards the Circular Economy 1: Economic and business rationale for an accelerated transition. Retrieved from http://ellenmacarthurfoundation.org/ (accessed: 25.12.2014).

Upstream Circularity	Downstream Circularity
Skills in circular product design	Capabilities in building reverse cycles

- New (service) business models
- Cross-sector collaboration across the value chain

Source: EMF 2013

Circular Economy as system innovation



Additionally, support of governments necessary

Necessary **coordination with others** (e.g. suppliers, value chain, customers)

Organisations can innovate independently (e.g. product redesign)

Source: Pinkse, J., Bohnsack, R., & Kolk, A. (2014). The Role of Public and Private Protection in Disruptive Innovation: The Automotive Industry and the Emergence of Low-Emission Vehicles. Journal of Product Innovation Management, 31(1), 43–60. https://doi.org/10.1111/jpim.12079.

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Collaboration as basis for circular innovation: two case examples

Upstream Circularity

Downstream Circularity

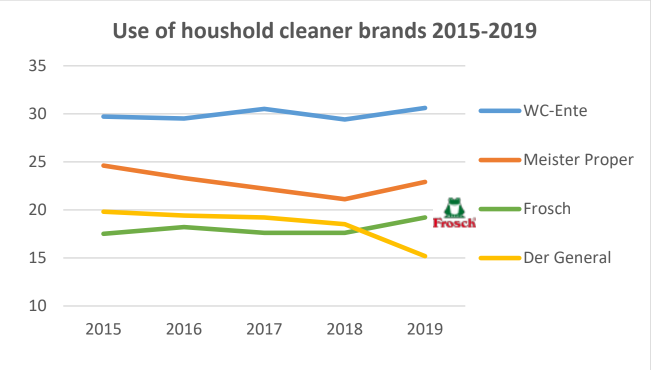
Skills in circular product design

Capabilities in building reverse cycles

Cross-sector collaboration across the value chain

Case study: Overview

CERTIFIED cradletocradle GOLD



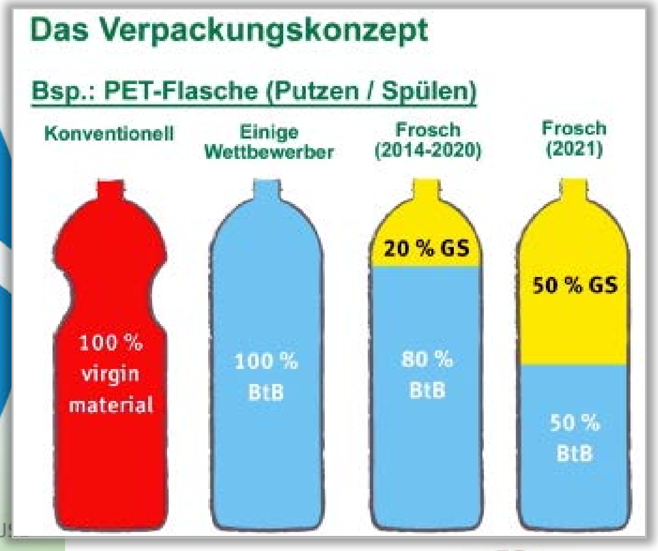
EMAS Geprüftes Umweltmanagement

Frosch

Voted by readers MOST TRUSTED BRAND 2015 Reader's Digest

Sources: Werner & Mertz Gruppe (2016), p.102; statista (2013)

Product redesign following cradle-to-cradle philosophy



Source: Product catalogue, Green care 2015-1, tana-Chemie GmbH, S.5 (20.02.2016)

Product composition as basis for circular design assessment

Product | **Parts** | **Components** | **Materials/Substances**

- Bottled detergent
  - Cleaning agent
    - Surfactant — Sodium laureth sulfate
    - Fragrance — 80-100 ingredients
    - Colorant — Food dye E 104
    - Solvent — Purified water
    - Acid — Citric acid
  - Packaging for detergent
    - Bottle
      - PET Recyclate (household collection) — 9 ingredients
      - PET Recyclate (bottle-to-bottle collection) — 14 ingredients
    - Cap/ Spray applicator
      - Pigments / colorants (green) — 14 ingredients
      - Additives — 8 ingredients
      - Polymers — 9 ingredients
      - Spring — 1 ingredients
    - Label
      - Polymer (basic material) — 1 ingredient
      - Printing inks — >100 ingredients
      - Laminat — 24 ingredients
      - Adhesives — 13 ingredients

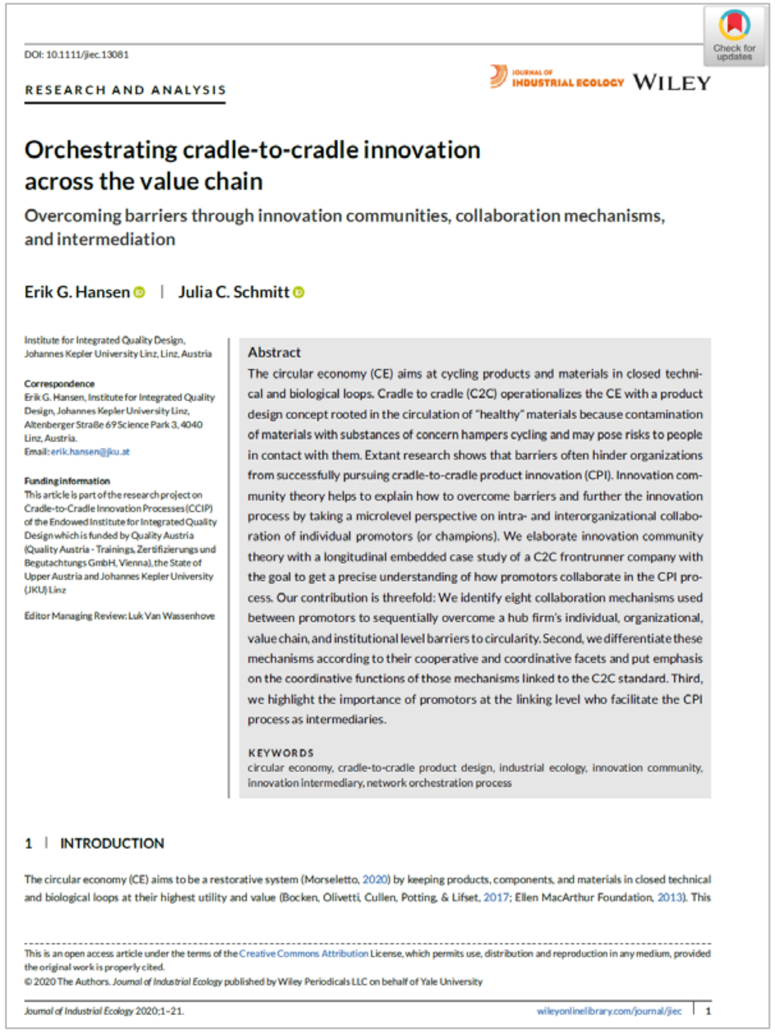
Mandatory scope for product certification (bottled detergent) [Cleaning agent]

Mandatory scope for *voluntary* separate bottle certification [Bottle]

Overall scope of case [all]

Source: Hansen, E. G., & Schmitt, J. (2020). Orchestrating Cradle-to-Cradle Product Innovation Across the Value Chain: Innovation Community Evolution, Collaboration Mechanisms, and Intermediation. Journal of Industrial Ecology. https://doi.org/10.1111/jiec.13081.

Collaboration processes in the circular redesign/innovation process


DOI: 10.1111/jiec.13081

RESEARCH AND ANALYSIS

JOURNAL OF INDUSTRIAL ECOLOGY WILEY

Orchestrating cradle-to-cradle innovation across the value chain

Overcoming barriers through innovation communities, collaboration mechanisms, and intermediation

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Funding information
This article is part of the research project on Cradle-to-Cradle Innovation Processes (CCIP) of the Endowed Institute for Integrated Quality Design which is funded by Quality Austria (Quality Austria - Trainings, Zertifizierungs und Begutachtungs GmbH, Vienna), the State of Upper Austria and Johannes Kepler University (JKU) Linz

Editor Managing Review: Luk Van Wassenhove

Abstract

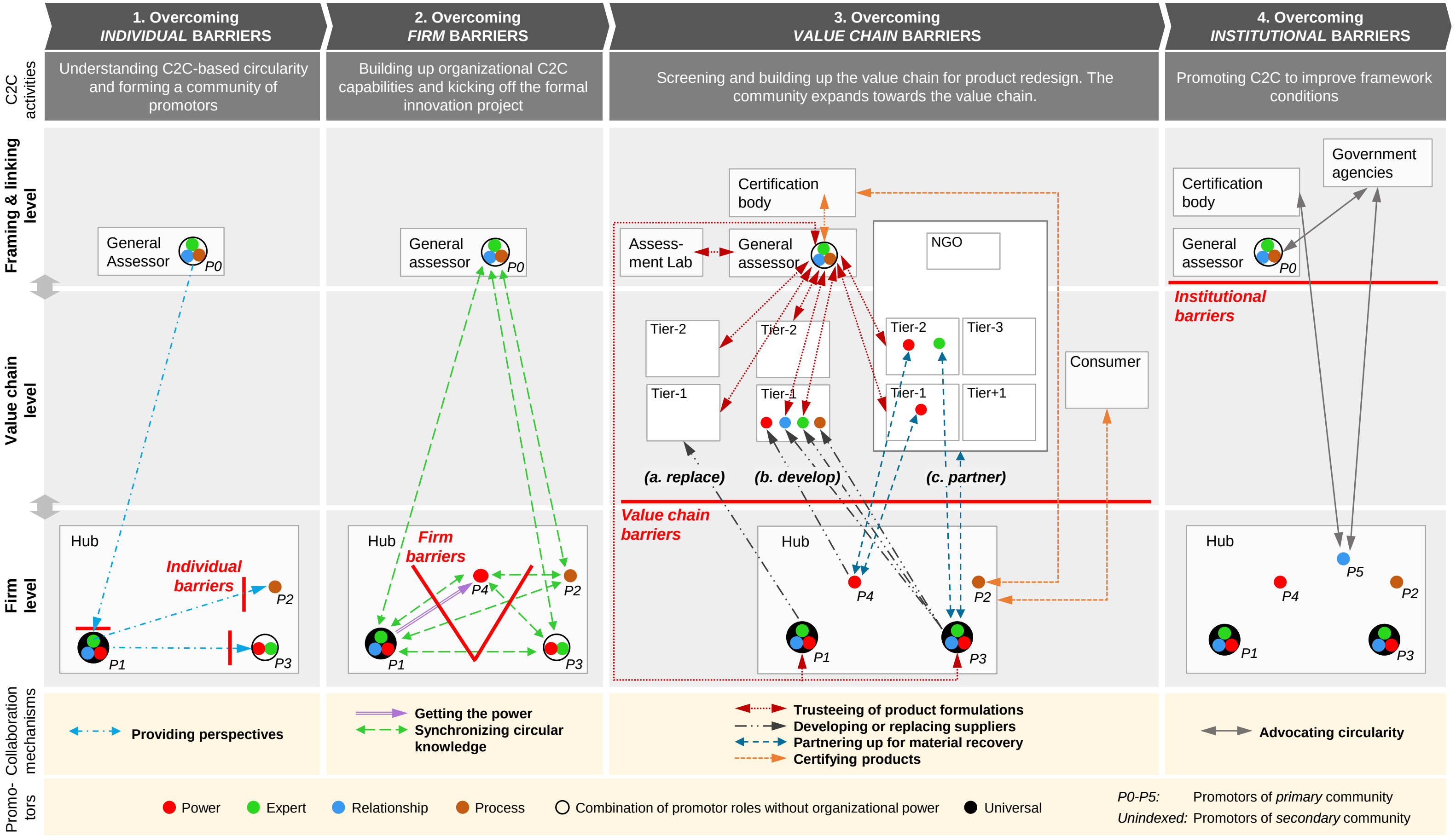
The circular economy (CE) aims at cycling products and materials in closed technical and biological loops. Cradle to cradle (C2C) operationalizes the CE with a product design concept rooted in the circulation of "healthy" materials because contamination of materials with substances of concern hampers cycling and may pose risks to people in contact with them. Extant research shows that barriers often hinder organizations from successfully pursuing cradle-to-cradle product innovation (CPI). Innovation community theory helps to explain how to overcome barriers and further the innovation process by taking a microlevel perspective on intra- and interorganizational collaboration of individual promotors (or champions). We elaborate innovation community theory with a longitudinal embedded case study of a C2C frontrunner company with the goal to get a precise understanding of how promotors collaborate in the CPI process. Our contribution is threefold: We identify eight collaboration mechanisms used between promotors to sequentially overcome a hub firm's individual, organizational, value chain, and institutional level barriers to circularity. Second, we differentiate these mechanisms according to their cooperative and coordinative facets and put emphasis on the coordinative functions of those mechanisms linked to the C2C standard. Third, we highlight the importance of promotors at the linking level who facilitate the CPI process as intermediaries.

KEYWORDS
circular economy, cradle-to-cradle product design, industrial ecology, innovation community, innovation intermediary, network orchestration process

1 | INTRODUCTION

The circular economy (CE) aims to be a restorative system (Morseletto, 2020) by keeping products, components, and materials in closed technical and biological loops at their highest utility and value (Bocken, Olivetti, Cullen, Potting, & Lifset, 2017; Ellen MacArthur Foundation, 2013). This

Journal of Industrial Ecology 2020;1–21. wileyonlinelibrary.com/journal/jiec 1



Source: Hansen, E. G., & Schmitt, J. (2020). Orchestrating Cradle-to-Cradle Product Innovation Across the Value Chain: Innovation Community Evolution, Collaboration Mechanisms, and Intermediation. *Journal of Industrial Ecology*, 1–21. https://doi.org/10.1111/jiec.13081.

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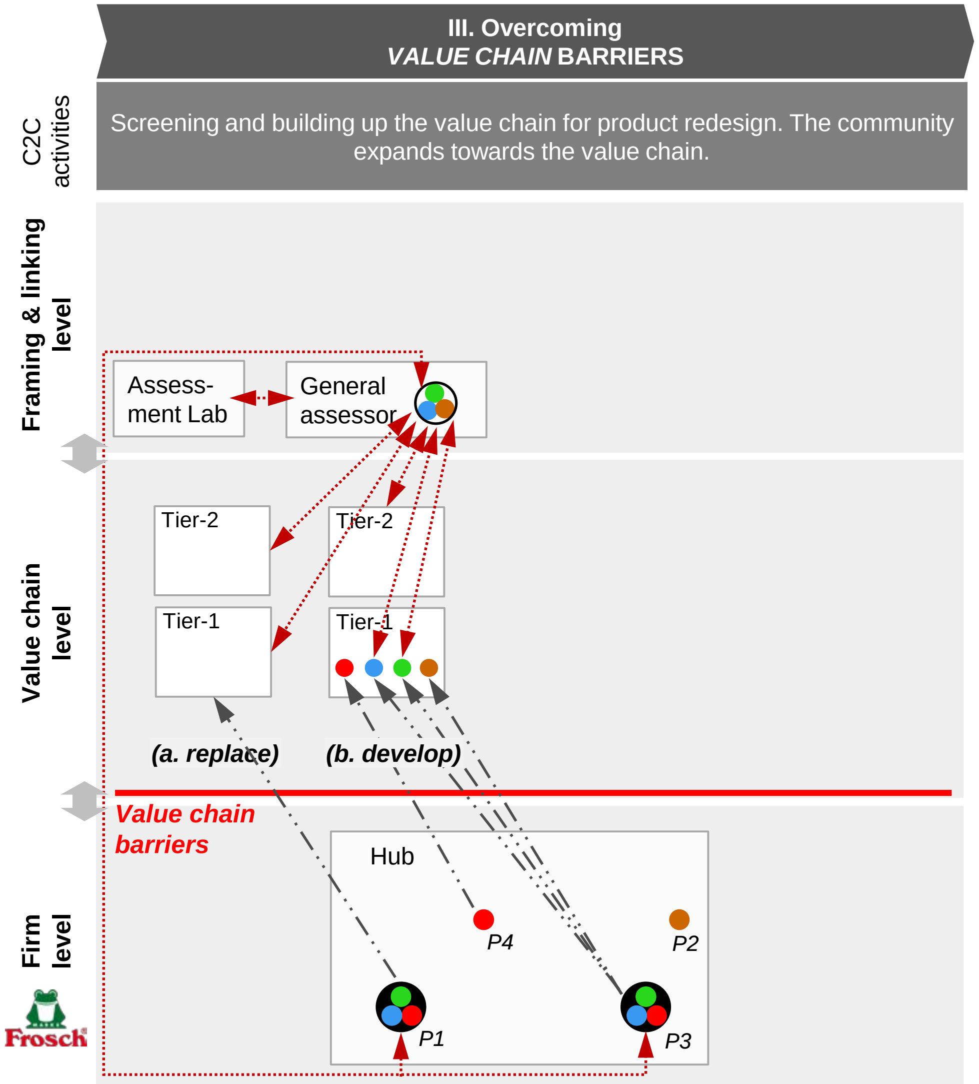
Phase III: Collaboration mechanisms to overcome value chain barriers



Source: Hansen & Schmitt (2020)

Mechanism M4 Trusteeing of product formulations

Coordinating non-disclosure agreement (NDA)-secured information sharing of material compositions to achieve required material transparency in the value chain.

Class	Name	Description
A	Optimal	The **material is ideal from a Cradle to Cradle perspective** for the product in question.
B	Optimizing	The material **supports largely Cradle to Cradle objectives** for the product.
C	Tolerable	**Moderately problematic properties** of the material in terms of quality from a Cradle to Cradle perspective are traced back to the ingredient. The material is still acceptable for use.
X	Not acceptable	**Highly problematic properties** of the material in terms of quality from a Cradle to Cradle perspective are traced back to the ingredient. The optimization of the product requires phasing out this ingredient or material.
Grey	Not characterised	This material **cannot be fully assessed** due to either lack of complete ingredient formulation, or lack of toxicological information for one or more ingredients.
Banned	Banned	BANNED FOR USE IN CERTIFIED PRODUCTS This material **contains one or more substances from the Banned list** and cannot be used in a certified product

Mechanism M5 Developing or replacing suppliers

Sharing knowledge with suppliers to develop their circular capabilities. In case of lacking cooperation in the innovation project, components are omitted or suppliers replaced.

Assessment of substances of concern (Cradle to Cradle 'Material Health'): going much beyond European chemical regulation (REACH)

Lfd - Nr.	CAS-Nummer	Bezeichnung	Funktion	abcx	abcx Kommentar	Gehalt %/ ppm
1	7732-18-5	Wasser		b		65-75
2	0815-55-7	Harz		b	No major concern expected with this polymer.	20-40
3	777-44-2	Lalasäureester		c	Moderate to high aquatic toxicity but biodegradable under aerobic and anaerobic conditions. The degradation product might exhibit reproductive toxicity; the issue is currently under regulatory dis-cussion. Causes serious eye damage/eye irritation (H318), moderate skin irritation (H315), moderate oral toxicity -Not expected to reach the environment in this use scenario, minor exposure to end users, and adequate protection of workers.	5-10
4			Pigment	grey	unbekannt	0-3
5			Lösemittel	grey	unbekannt	0,5-5
6	4711-23-6	Pigment	Pigment	x	Halogenated organic compound, contains copper. Loss of the scarce resource Cu.	1
7	4712-34-1	Colora 5	Pigment	b	Chinacridon-Derivat	2
8	22-33-45454	"1,2-Konservodol	Konservierungs- mittel	c	Generally sensitization potential. Considered EXPOSURE very limited (very small amounts). Severely toxic for aquatic organisms, slowly aerobically biodegradable and not bioaccumulative.	ca. 100 ppm
9	11-22-232	"1-halo-3-phantasto-diol"	Konservierungs- mittel	x	Halogenated preservative. Sensitizer (BfRCat B; Mak Sh), high oral and dermal toxicity. Highly toxic to aquatic organisms, but expected to degrade at low concentrations. High amounts of this preserva-tive are not expected to enter water streams sistematicallyin this use scenario.	200 ppm
10	7777-2-33	Eisen (23)-dingstat	Trocknungs-beschleuniger	x	CMR: According to REACH considered reprotoxic(H316).	200 ppm

Non-regulated toxic substance to be eliminated

Regulated toxic substance, but below REACH treshold

Source: based on EPEA Switzerland GmbH, Albin Kälin

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So ... how on earth do I get it repaired now?

Send your product to Apple

Online or over the phone, we'll arrange shipment for your product to an Apple Repair Center — all on your schedule and without an appointment. This service is available for most Apple products.

Apple Repair

Source: http://www.express.co.uk/life-style/science-technology/641336/Broken-iPhone-Screen-Apple-Store-Reuse-and-Recycling (21.6.2016) nbs.net/articles/4-ways-to-make-your-business-circular

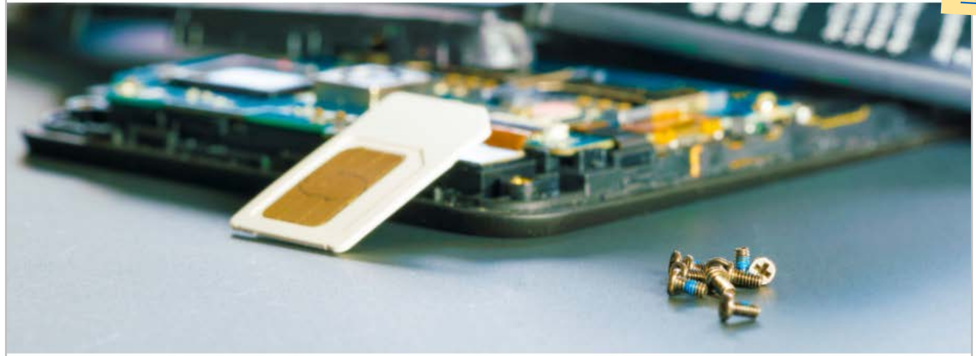
Network for Business Sustainability

SEARCH

HOME OUR RESOURCES OUR COMMUNITY ABOUT US ENGAGE | FR

4 Ways to Make Your Business Circular

Alisha Tuladhar and Maya Fischhoff · May 18, 2021



Companies can engage with the circular economy in four different ways. Here's how to make your choice.

If the circular economy is the destination, there are a number of ways to get there. And "SmartMan," "TelcoPro," "TelcoBasic," and "MaintainOp4" provide models.

These are the names that researchers gave different companies in the European smartphone market. Researchers Erik Hansen (Johannes Kepler University) and Ferdinand Revellio (Leuphana University & Johannes Kepler University) spent four years looking at the strategies that different manufacturers and retailers used to become more circular. Their insights apply to multiple industries.[1]

Why move to a circular model? Many say that the circular economy is the future of sustainability. That's because a circular economy provides ways to keep materials and products in use, by repairing, reusing, and finally recycling them. Used products don't just

Watch video @ Disruptive Innovation Festival:
https://www.youtube.com/watch?v=o5k7SaBhPwY

Source: https://www.nbs.net/articles/4-ways-to-make-your-business-circular (9.6.2021)

DOI: 10.1111/jiec.13016

RESEARCH AND ANALYSIS

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Circular value creation architectures

Make, ally, buy, or laissez-faire

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Funding information
The contributions by the authors were partly funded by the Volkswagen Foundation and the State of Lower Saxony as part of the project eCoInnovateIT (Project no. VWZN3037) as well as the Endowed Institute for Integrated Quality Design (IQD) at Johannes Kepler University Linz (JKU), Austria, which is co-funded by Quality Austria - Trainings, Zertifizierungs und Begutachtungs GmbH, the State of Upper Austria, and the JKU.

Editor Managing Review: Charles Corbett

Abstract

Slowing and closing product and related material loops in a circular economy (CE) requires circular service operations such as take-back, repair, and recycling. However, it remains open whether these are coordinated by OEMs, retailers, or third-party loop operators (e.g., refurbishers). Literature rooted in the classic make-or-buy concept proposes four generic coordination mechanisms and related value creation architectures: vertical integration, network, outsourcing, or doing nothing (laissez-faire). For each of these existing architectures, we conducted an embedded case study in the domain of smartphones with the aim to better understand how central coordinators align with actors in the value chain to offer voluntary circular service operations. Based on the above coordination mechanisms, our central contribution is the development of a typology of circular value creation architectures (CVCAs) and its elaboration regarding circular coordination, loop configuration, and ambition levels. We find that firms following slowing strategies (i.e., repair, reuse, and remanufacturing) pursue higher degrees of vertical integration than those following closing strategies (i.e., recycling) because of the specificity of the assets involved and their greater strategic relevance. The typology also shows that higher degrees of vertical integration enable higher degrees of loop closure (i.e., from open to closed loops) and better feedbacks into product design. Furthermore, we differentiate the understanding on third-party actors by distinguishing between independent and autonomous loop operators. Overall, we strengthen the actor perspective in product circularity literature by clarifying the actor set, their interrelationships, and how they form value creation architectures.

KEYWORDS
business model innovation, circular economy, consumer electronics, corporate sustainability, partnerships, product design

1 | INTRODUCTION

The circular economy (CE) has emerged as an umbrella concept for integrating various life cycle-based approaches from research and practice with the aim to decouple economic growth from absolute resource use (Blomsma & Brennan, 2017). Acting as a long-term vision for closed product, parts, and material loops, the CE concept aims to displace primary production, while evading potential rebound effects (Zink & Geyer, 2017). It covers both technical (i.e., products of use) and biological (i.e., products of consumption) cycles (EMF, 2012; McDonough & Braungart, 2002). We focus on product circularity, which goes beyond traditional waste management approaches by covering slowing strategies for product life extension (repair, reuse, remanufacture) and closing strategies for material recovery (i.e., recycling) (Bocken, de Pauw, Bakker, & van der Grinten, 2016; Bocken, Olivetti, Cullen, Potting, & Lifset, 2017; Lüdeke-Freund, Gold, & Bocken, 2018; Stahel, 2010). Taking a systems perspective, it spans diverse actors, organizations, and life cycle stages (EMF 2012; Geissdoerfer, Savaget, Bocken, & Hultink, 2017; Stahel, 1984), transcending the narrow

1250 | wileyonlinelibrary.com/journal/jiec … Industrial Ecology 2020;24:1250–1273.

Underlying research

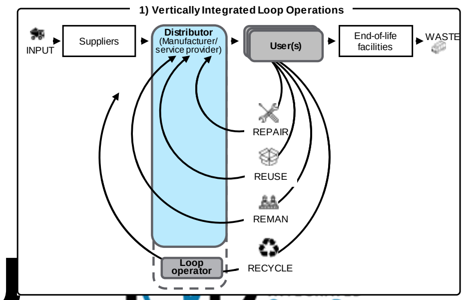
Typology of Circular Value Creation Architectures

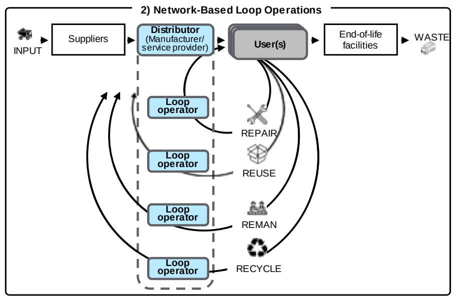
Cooper-ation most likely

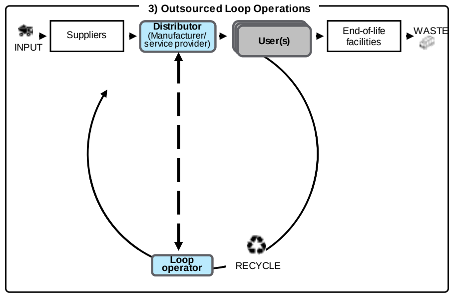
Send your product to Apple

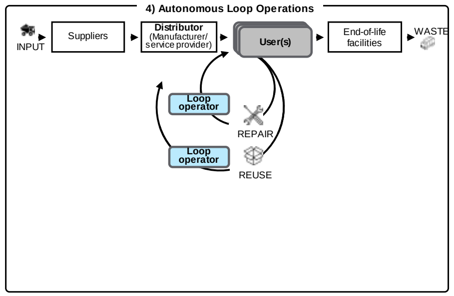
Authorized Service Provider

	Circular value creation	Circularity as strategy		Circularity as compliance	Linear value creation
Drive circularity internally	**Vertically integrated**	**Network-based**	**Outsourced**	**Autonomous**	**Leave circularity to others**
	← **Coordinated** →			← **Uncoordinated** →	
Loop integration by focal actor	**Make** Vertical integration as core competency and source of innovation	**Ally** Strategic partnerships to develop a profitable life-cycle oriented niche	**Buy** Framework contracts for CSR and cost focused end-of-pipe solutions	**Laissez-faire** No loop coordination and ambivalent behavior towards autonomous LOs	
Loop focus and loop closure	**Holistic** Closed-loop system with circular product design	**Broad** Discrete closed and open loops as add-on services	**Narrow** Standardized open loops along compliance path	**Ignore** Single loops developed by autonomous market actors	
Circular ambition level	**Lead the industry** Strong inner loops and closed-loop system	**Strategic** Fast scaling with profitable state-of-the-art solutions	**Compliance plus** Incremental improvements of end-of-pipe solutions	**Reactive** None, but innovative solu-tions by autonomous LOs	



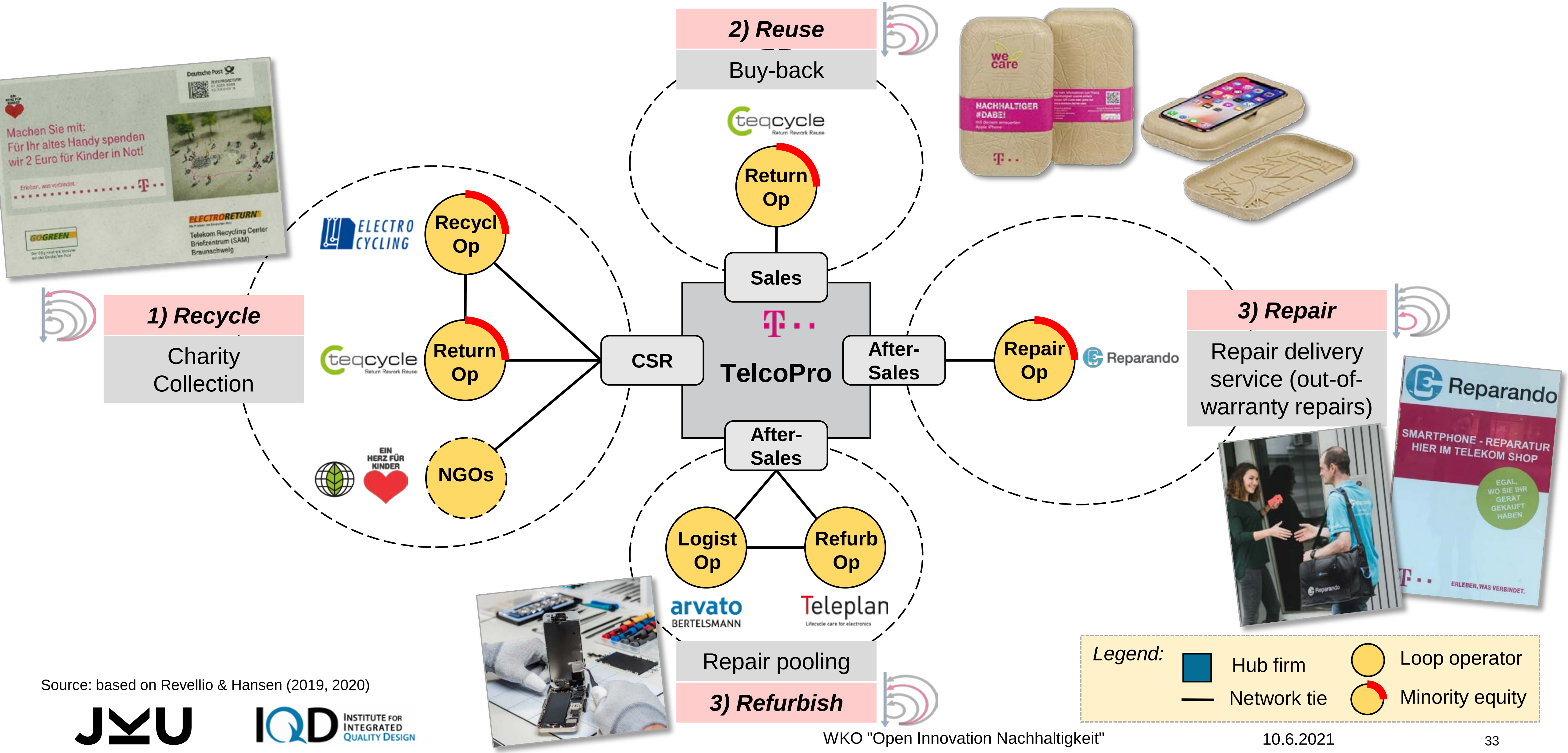






Source: based on Hansen & Revellio, 2020

TelcoPro's "Ally" coordination: circular services and related loop operators



Source: based on Revellio & Hansen (2019, 2020)

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AGENDA

1. Challenges and motivation
2. Today's downcycling economy
3. Principles of a (real) circular economy
4. Collaboration becomes key to innovation in the area of ...

   ... circular product redesign

   ... circular service operations (=reverse flows)
5. Conclusion

Conclusion

- Circular Economy: Long term development driven by political, economic and science spheres
  - Goal: decouple growth from resource use while creating regional (service) jobs
  - Strategies:
    - technical cycling (repair/maintain, reuse, remanufacture, recycle)
    - biological cycling for specific applications requiring biodegradability
  - Prerequisite for effective cycling: healthy materials
- Cross-sector collaboration basis for circular product redesign and reverse service development
- Collaboration in circular *product* (re)design
  - Supply chain screening and redevelopment of materials/components
  - New partnerships for sourcing circular/recycled materials
  - Often a need for intermediaries (knowledge trustees) to broker knowledge between organisations
- Collaboration for circular *services* addressing reverse cycles (e.g. repair, take-back, remanufacture)
  - Make-ally-or-buy decision vs. emergence of autonomous actors
  - Make vs. buy drives intensity of learning

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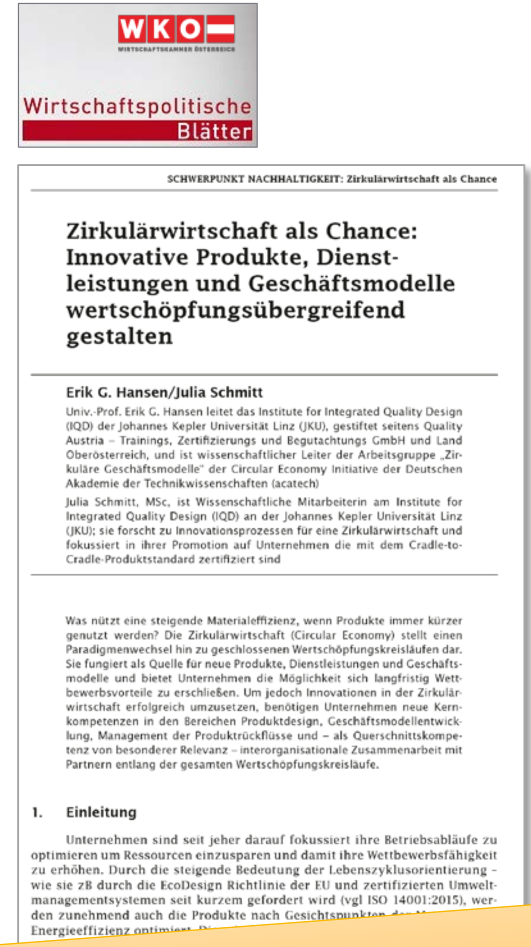

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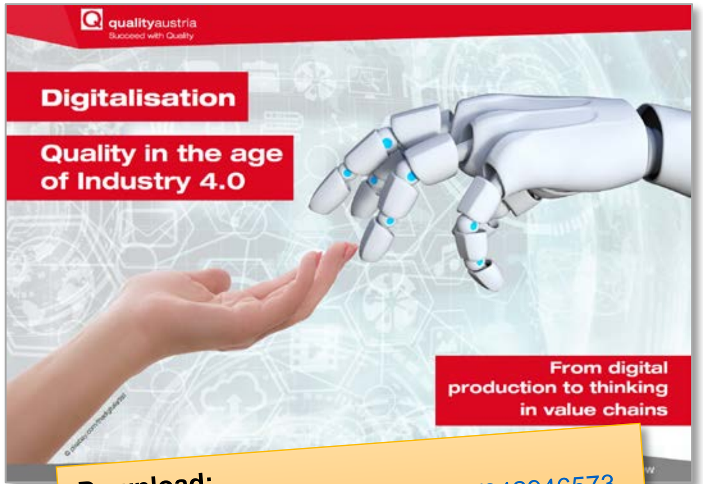

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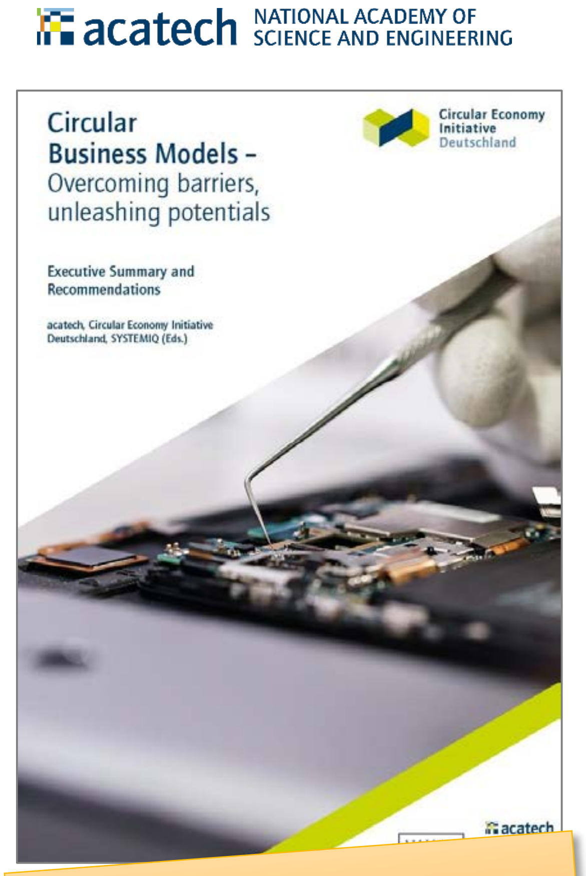

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