

CIRCULARITY IN THE PLASTIC AND PACKAGING INDUSTRY

*Malou van der Vegt
3rd of October 2022*

INTRODUCTION: MALOU VAN DER VEGT

BACKGROUND

- Industrial Design Engineering
- Sustainable Packaging Design

LECTURER

- Industrial Engineering and Management

RESEARCHER

- Centre of expertise Smart Sustainable Cities



INTRODUCTION: MALOU VAN DER VEGT

1

Workshops

barriers & enablers
for recycled plastic

2

Case studies

good practices
circular economy
business models

3

Case studies

business support
redesigning products
with recycled plastic

4

CE roadmap

plastic roadmap for
IEM and AM

CONTENT

- Why do we use plastic?
- Why do we use packaging?
- Options for sustainable polymers
 - Recycling
 - Bioplastics
- Recycling or bioplastics? – what is better?
- Circularity
- Material & value flows
- Case study approach

SUSTAINABILITY

SUSTAIN

ABILITY

Sustainable Development =
“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

- Brundtland report, 1987



'PLASTIC SOUP'





‘METAL SOUP’

WHY DO WE USE PLASTIC?

- Convenience: light-weight, fast to manufacture
- Attractive: transparant, many shapes
- Cheap

Can we go without
plastic?

DILEMMA: PLASTIC SLEEVE AROUND CUCUMBER?

PRODUCT <=> PACKAGING



Packaging is 10% of environmental impact, cucumber is remaining 90%

Waternverbruik

Verbruik voor kweken/fabriceren, wassen, transport, afvalbeheer, enz.

375



komkommer

0,02 liter



Plastic-verpakking

CO₂-uitstoot

uitstoot met betrekking tot kweken/fabriceren, wassen, transport, afvalbeheer, enz.

4.500g CO₂



komkommer

10g CO₂



Plastic-verpakking

WHY DO WE USE PACKAGING?

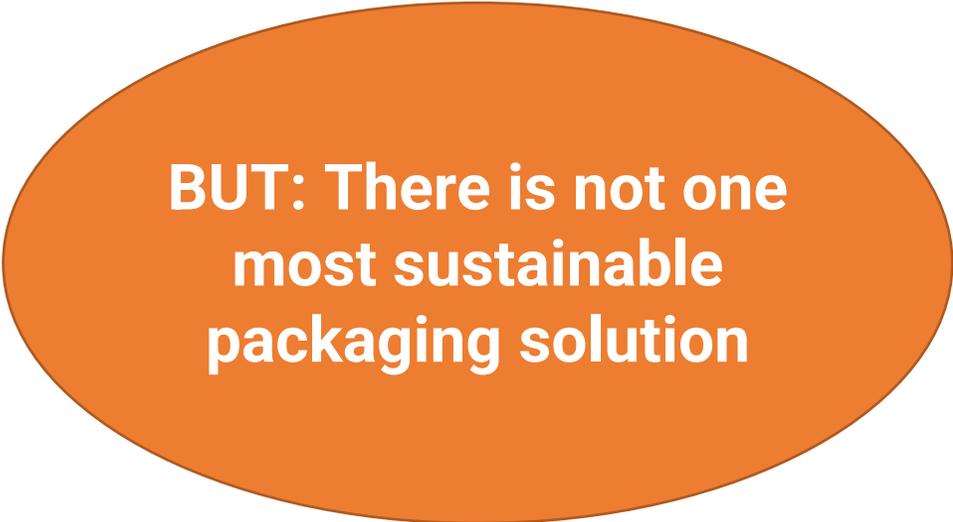
FUNCTIONS OF PACKAGING

1. To protect & preserve
2. To distribute
3. To inform

WHY DO WE USE PACKAGING?

SUSTAINABLE OPTION DEPENDS ON:

- Product
- Context
- Use



**BUT: There is not one
most sustainable
packaging solution**

DILEMMA: PLASTIC SLEEVE AROUND CUCUMBER?

CHOOSING PLASTIC SLEEVE:

- Substantiate choices as company
- 'Recyclable' packaging
- State disposal options on label



WHY DO WE USE PLASTIC?

- Convenience: light-weight, fast to manufacture
- Attractive: transparant, many shapes
- Cheap

But also:

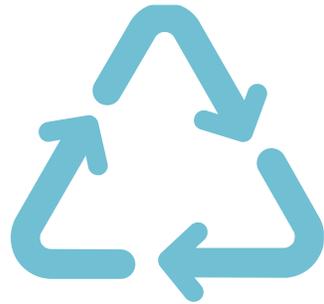
- Shelf-life
- Hygiene
- Safety

Can we go without
plastic?

SUSTAINABLE POLYMERS – WHICH OPTIONS?



SUSTAINABLE POLYMERS – WHICH OPTIONS?



RECYCLING



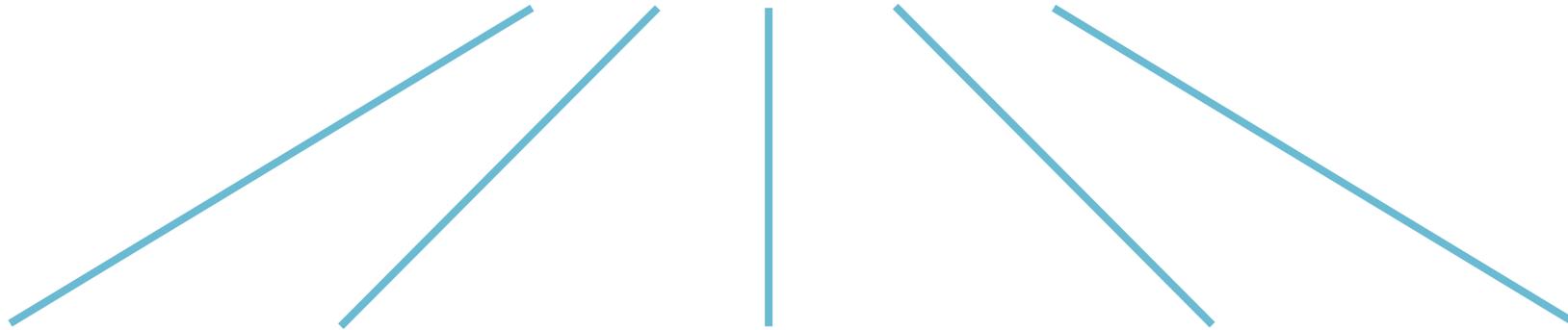
BIOPLASTICS



CIRCULARITY

SUSTAINABLE POLYMERS – WHICH OPTIONS?

RECYCLING



**MECHANICAL
RECYCLING**



**CHEMICAL
RECYCLING**



**INDUSTRIAL
RECYCLED
MATERIALS**



**POST-CONSUMER
RECYCLED
MATERIALS**



**DESIGN FOR
RECYCLING**

PLASTIC RECYCLING



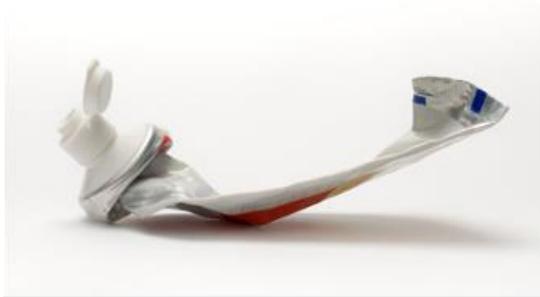
PLASTIC RECYCLING



**Limited recyclability
(contaminations): 24%**



**Poor sortability
(design) :13%**



Not recyclable: 1%

PLASTIC WASTE



**Limited recyclability
(technologies): 19%**

The term *recyclable* does not necessarily mean that the material is also recycled in industry. It must also be correctly collected, sorted and reprocessed.

- A separate stream is needed (**enough volume**)
- Correct sorting should be possible (**technologies**)
- There should be application possibilities (**market**)
- There must be an economic value (**good quality**).



**Low quality (mix
plastics): 17%**

PLASTIC RECYCLING

RECYCLING



DOWNCYCLING



UPCYCLING



EXAMPLE: LOW-QUALITY MATERIALS (SAVE PLASTICS)



Low quality mix
plastics



Reliable stream
& lower prices



High
contaminations

PLASTIC RECYCLING – NEW TECHNOLOGIES

- Barcode scanning
- Chemical recycling
- Plastic scanner
- Material passport



Toepassen van barcode scanning in recycle proces



Plastic scanner 'scant' materiaal van product

PLASTIC RECYCLING - MATERIAL RECOVERY



3D-print afval – granulaat – recycalaat printen

GREENWASHING



...ze bestaan voor 35 procent uit plastic en die hoeveelheid plastic is...

PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

METHOD: 1) FOCUS GROUPS

**8 focus
groups**

**81
people**

**74
organisations**

PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

RESULTS: 1) BARRIERS & ENABLERS



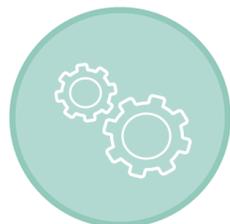
REGULATORY

Lack of clear policies and (stimulating) regulations



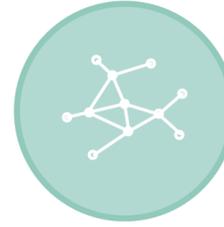
ECONOMIC

Price differences between virgin & recycled



TECHNICAL

Lower material quality & uncertainties about quality



SYSTEMIC

Availability and reliable stream of recyclate (from sufficient quality)



ORGANISATIONAL

Lack of short-term goals



CULTURAL

Lack of consumer demand/willingness & lack of knowledge

EXAMPLE: OUTDOOR FURNITURE (KETER)



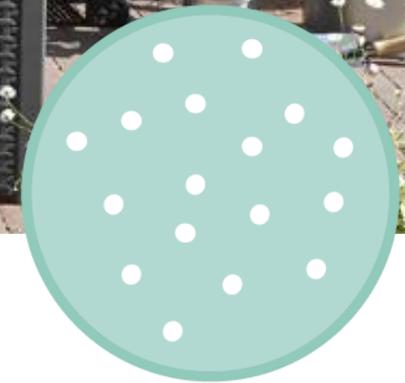
Over 40%
recycled
materials



Communicate
about use

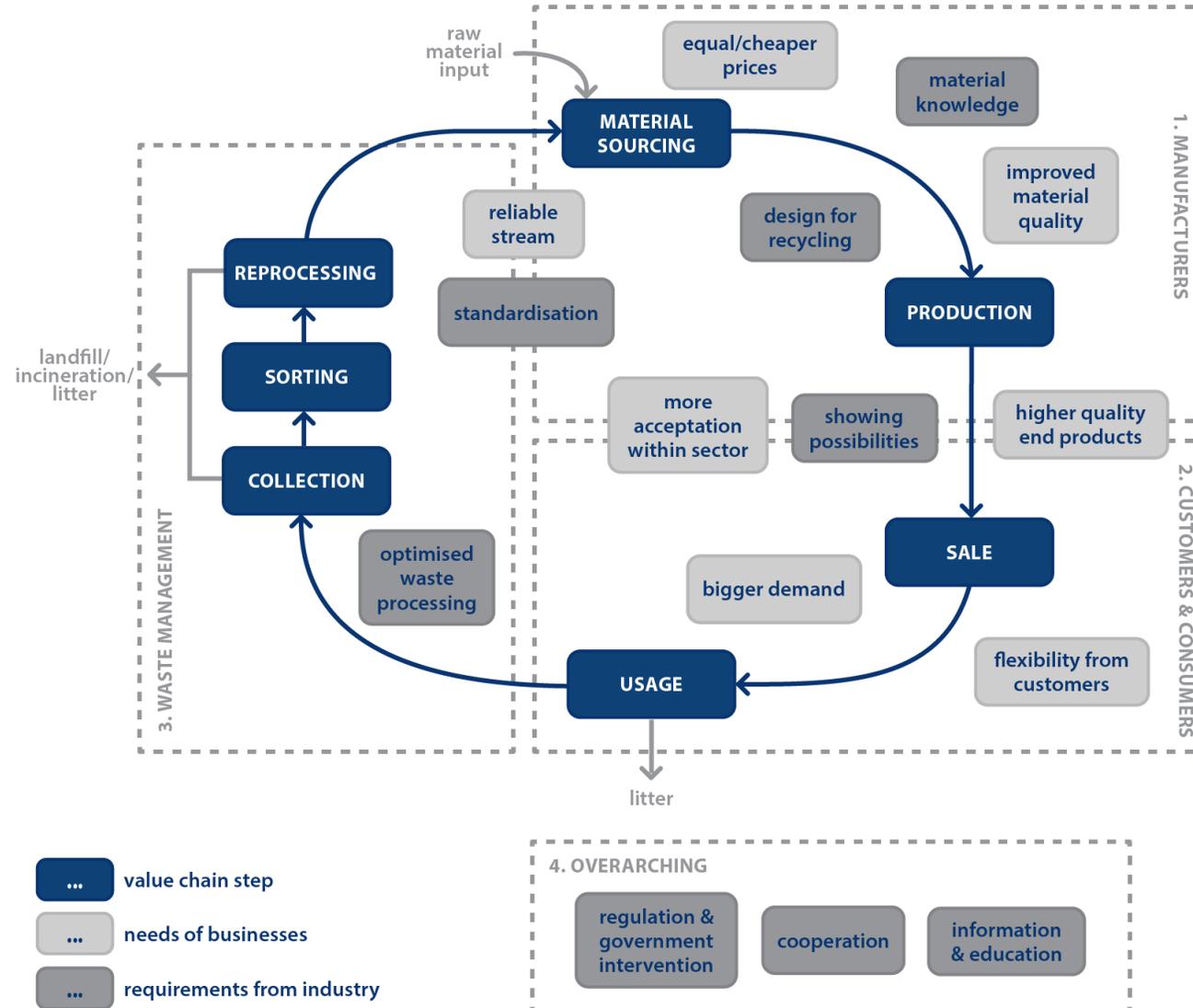


Take recycled
materials into
account from start



Use
imperfections
(include or hide)

PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

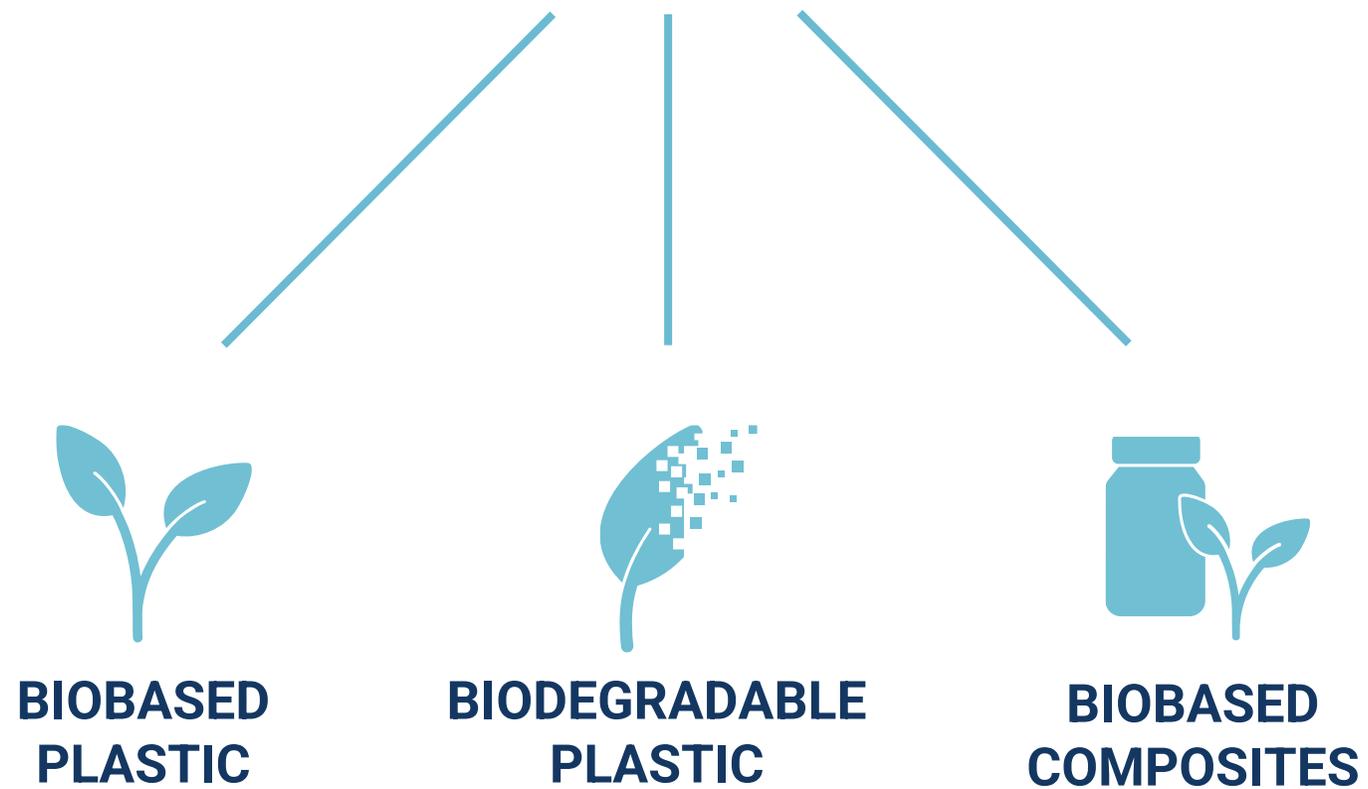


SUSTAINABLE POLYMERS – WHICH OPTIONS?

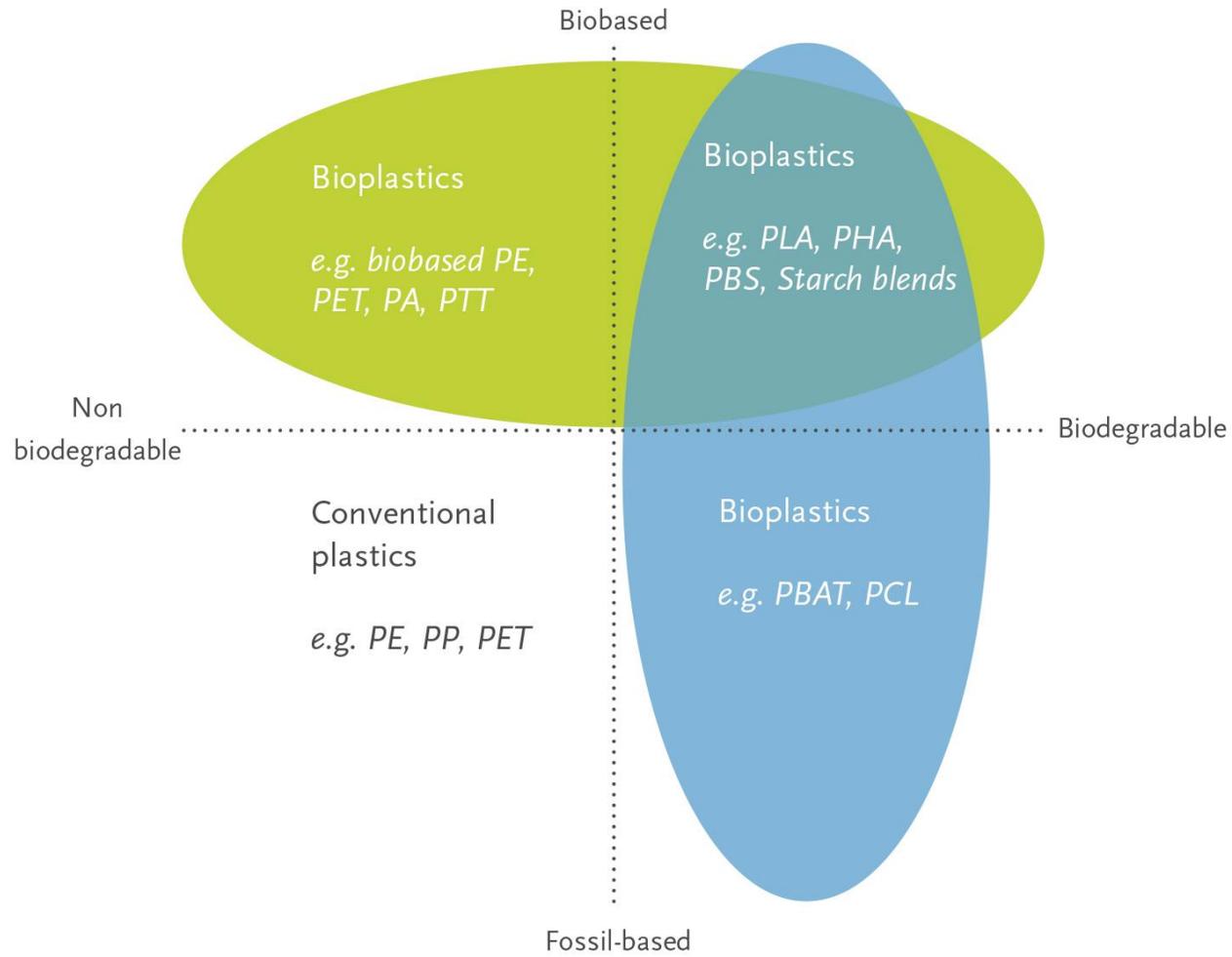


SUSTAINABLE POLYMERS – WHICH OPTIONS?

BIOPLASTICS



BIOPLASTICS – BIOBASED VS. BIODEGRADABLE



Biobased: the material is obtained from biomass (plants, e.g. sugar cane, maize, starch). This is about the **origin** of the material.



Biodegradable: the material breaks down under specific conditions. This is about what happens to the material at **end-of-life**.

Biobased ≠ Biodegradable

BIOPLASTICS

let's talk about bio-based plastic



WHEN WE TALK ABOUT "PLASTICS", THE MAIN CONCEPTS TO TAKE INTO ACCOUNT ARE...

fossil-based plastics

the material or product is (partly) derived from petrochemicals, and it is commonly thought of as "traditional" plastic.

VS.

bio-

the material or product is derived from biomass, renewable resources, or agricultural products that come from plants such as sugarcane, cellulose, etc.

non biodegradable

the material cannot be decomposed or degraded by natural agents.

VS.

biodegradable

Biodegradation is a chemical process during which micro- and other organisms that are available in the environment convert materials into natural substances such as water, carbon dioxide, and compost (artificial additives are not needed). It depends on the environmental conditions (e.g. location or temperature), on the material and on the application.

BUT THOSE KEY POINTS ARE IMPORTANT AS WELL...

PLASTIC is defined as "**COMPOSTABLE**" when it undergoes degradation by biological processes during composting to yield CO₂, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials and that leaves no visible, distinguishable, or toxic residue.



a **PLASTIC MATERIAL** is defined as a **BIOPLASTIC** if it is either bio-based, biodegradable, or features both properties.



"**BIODEGRADABLE**" does not necessarily mean "**COMPOSTABLE**". Biodegradable and compostable plastic products comply with the EN 13432: 2002 standard (packaging products) or with the EN 14995: 2007 standard (other products).



"**BIO-BASED**" does not necessarily mean "**BIODEGRADABLE**"!



"**BIOPLASTIC**" and "**BIO-BASED PLASTIC**" are not interchangeable terms.



Bioplastics are also considered plastic in the EU. That is why, just like conventional plastic, these are prohibited in products under the SUP directive (including cutlery, plates, cotton swabs, etc.)

BIOPLASTICS

Problems with biodegradable packaging

- Degradation under specific conditions
- No solution for pollution
- Converted into CO₂, water and methane
 - Little biomass
 - Material disappears from the value chain
- Recycling or incineration yields more energy
- Degradation time is too long for composters (3-4 weeks vs. 12 weeks)
- Labels confuse consumers
- Misunderstandings regarding plastic, biobased, biodegradable
- Problems for plastic recycling process
 - Possible rejection of whole batch

There are options for using biodegradable plastics if the packaging still contains organic material (e.g. coffee capsules, tea bags, organic waste bags) or, for example, on a product (sticker on banana peel). Other options are, for example, catering or airplane meals, where the packaging can be thrown away together with the food residues.

BIOPLASTICS – BIOCOSMOSITES

Only 'recyclable' if:

- Separate stream
- Or large enough volumes

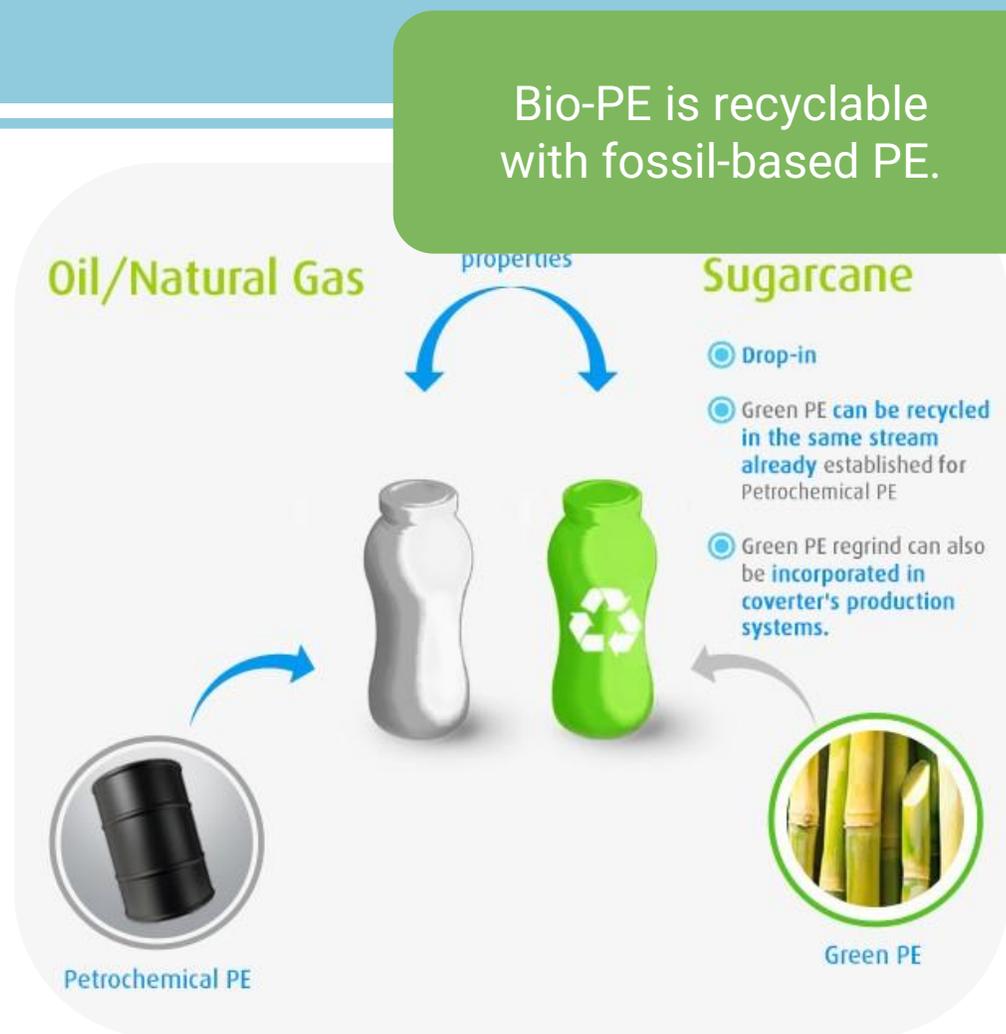


Biocomposite: composite of two materials, often plastic is mixed with a fiber (e.g. wood, hemp), of which one or both are biobased.

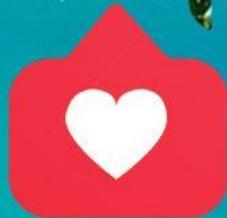
EXAMPLE: BIOBASED MATERIALS



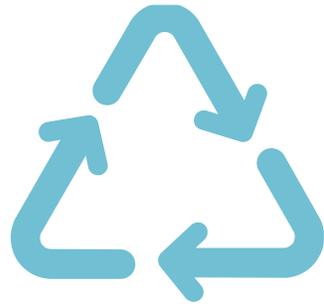
**PONT
GREEN**
member of the Pont Europe Group



EDIBLE SIX-PACK RING



SUSTAINABLE POLYMERS – WHICH OPTIONS?



RECYCLING



BIOPLASTICS

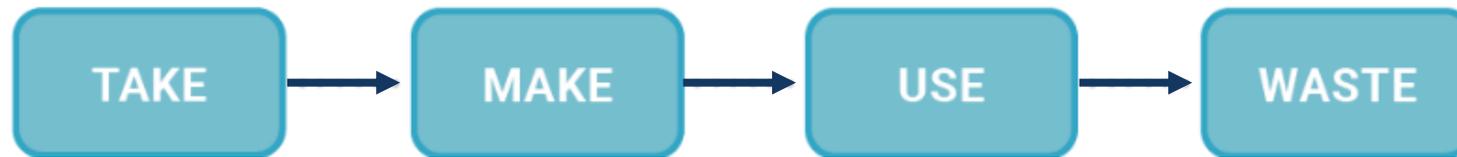
**Which option
is better?**

CIRCULARITY

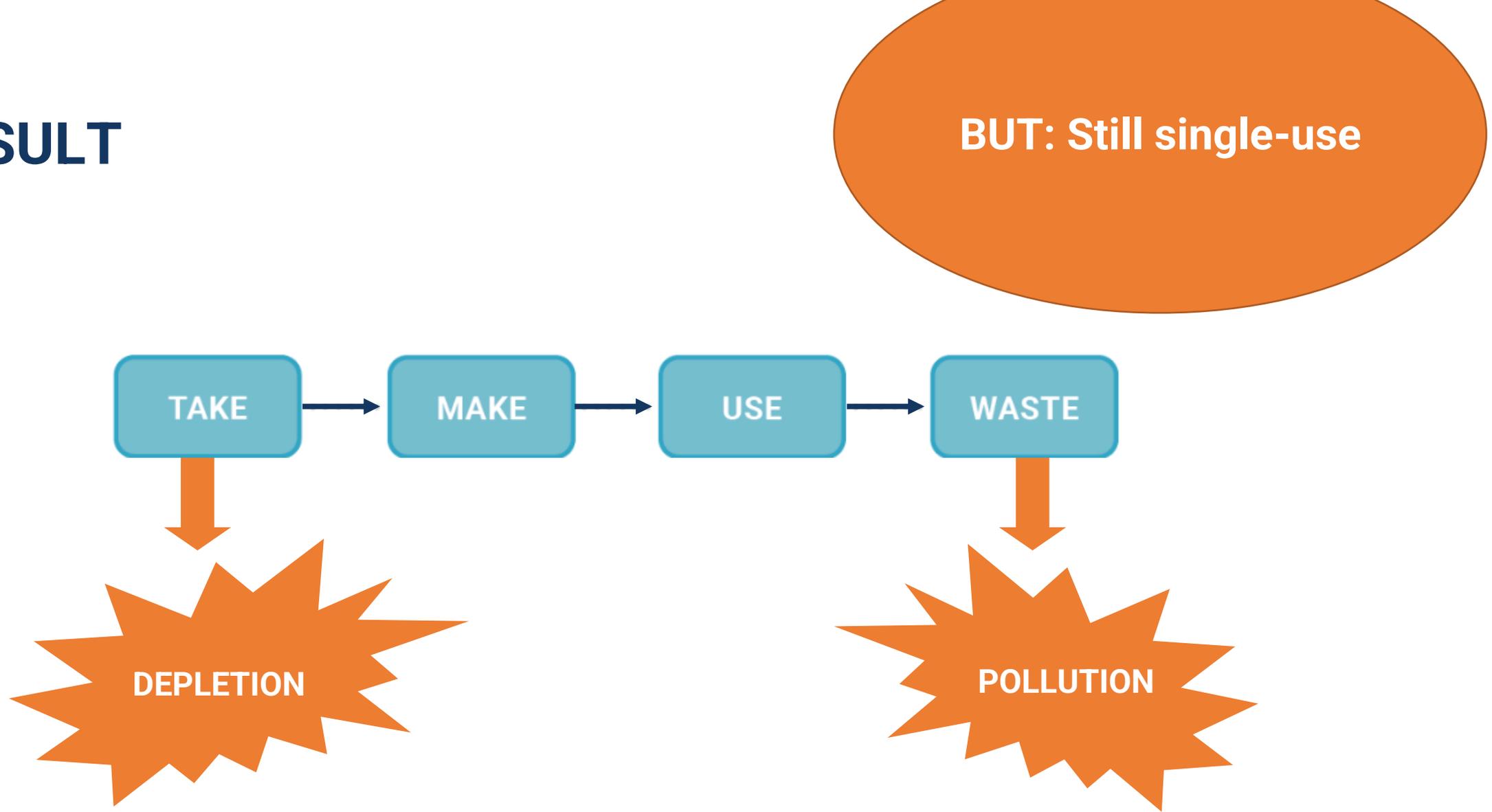
DILEMMA: BOTTLING OF WATER



LINEAR ECONOMY



RESULT

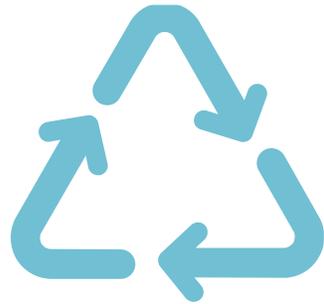


THE ISSUE



Earth Overshoot Day 2021 fell on July 29.

SUSTAINABLE POLYMERS – WHICH OPTIONS?



RECYCLING

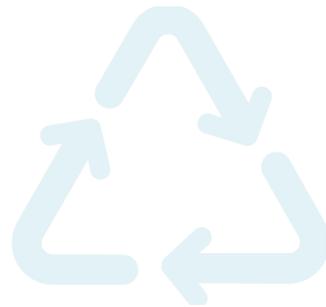


BIOPLASTICS



CIRCULARITY

SUSTAINABLE POLYMERS – WHICH OPTIONS?



RECYCLING

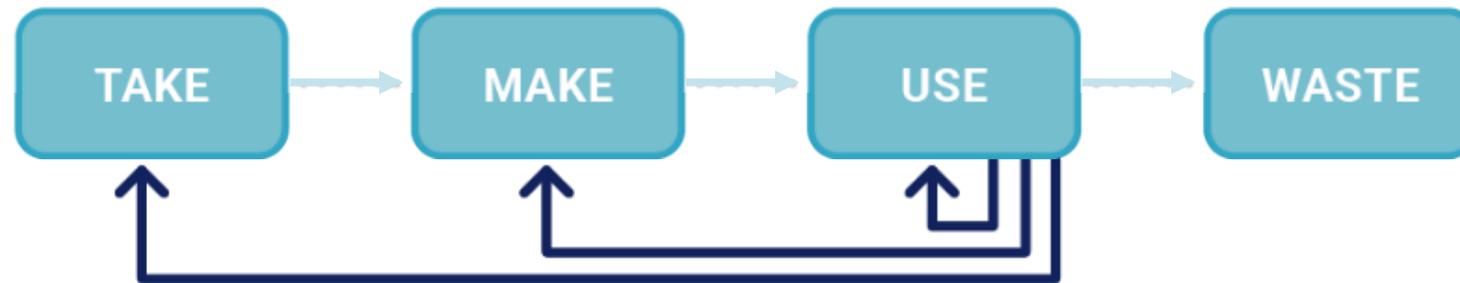


BIOPLASTICS



CIRCULARITY

CIRCULARITY - CIRCULAR ECONOMY

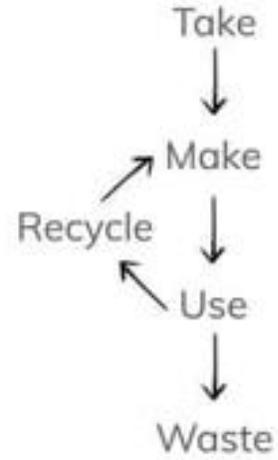


LINEAR VS. RECYCLING VS. CIRCULAR ECONOMY

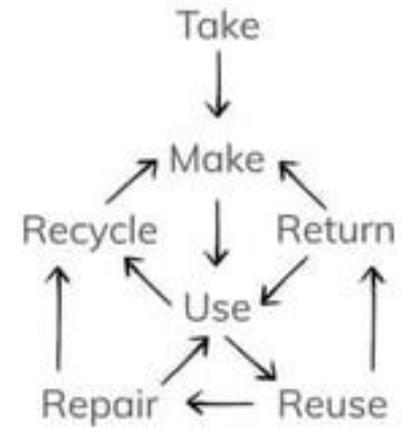
LINEAR ECONOMY



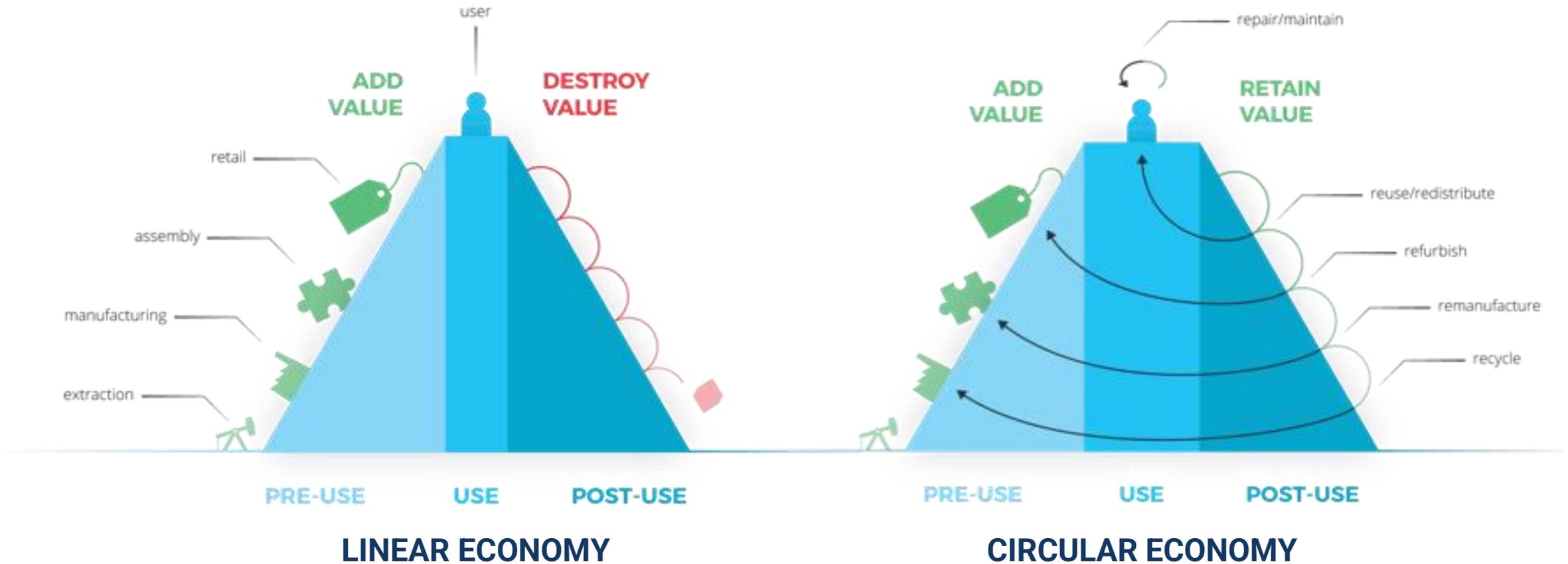
RECYCLING ECONOMY



CIRCULAR ECONOMY

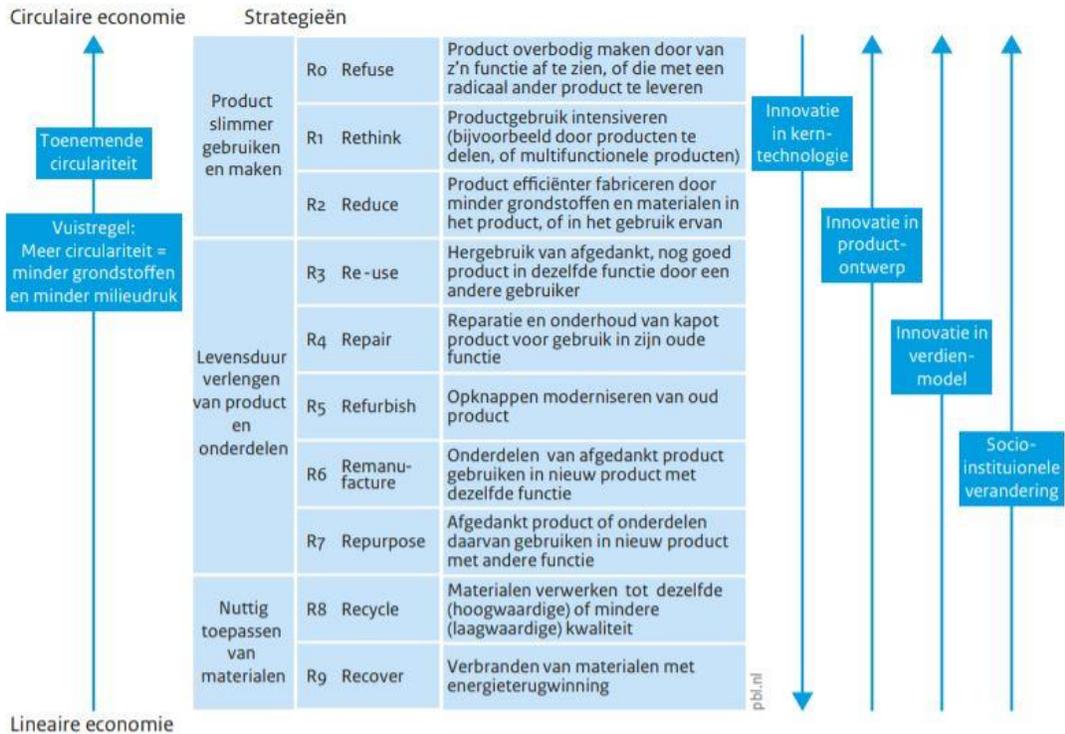


CIRCULARITY - VALUE HILL



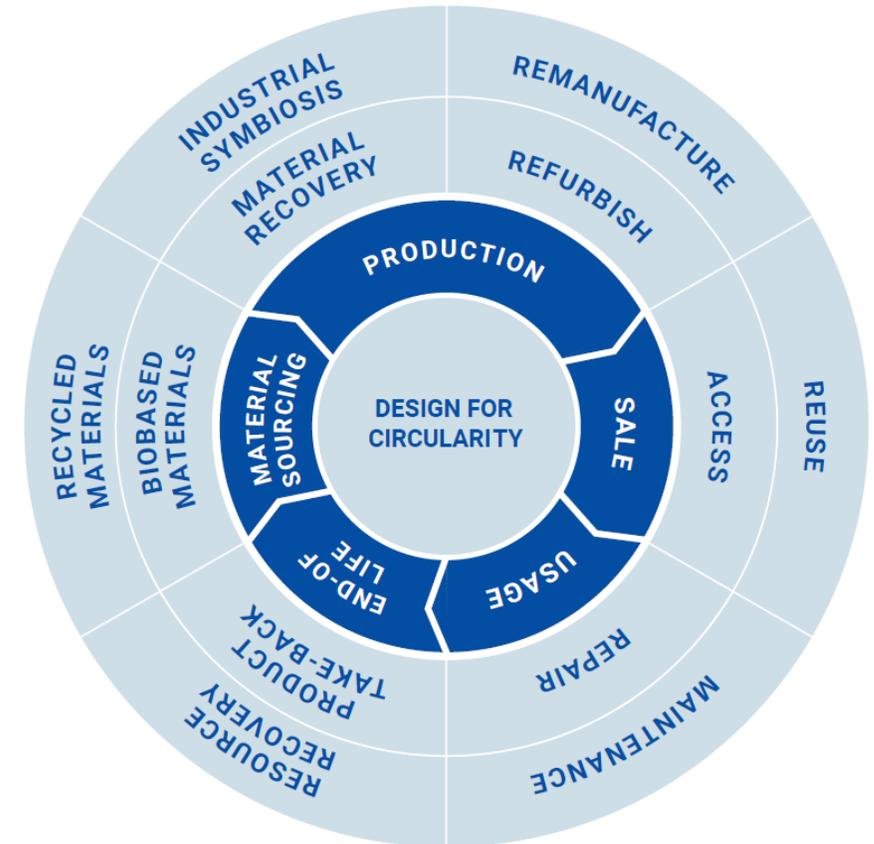
CIRCULARITY - CIRCULAR STRATEGIES

Prioriteitsvolgorde van circulariteitsstrategieën en rol van innovatie in productketen



Bron: RLI 2015; bewerking PBL

www.pbl.nl



Source: PBL, 2015

Source: Van der Vegt et al., 2021

EXAMPLE: BOTTLING OF WATER



Nu ook statiegeld
op **kleine plastic
flesjes.**

✓
Graag met dop

✓
Statiegeldlogo

✓
Barcode goed
scanbaar

✓
Onbeschadigd



LEVER ZE
HIER IN!

STATIEGELD
NEDERLAND
statiegeld@nederland.nl

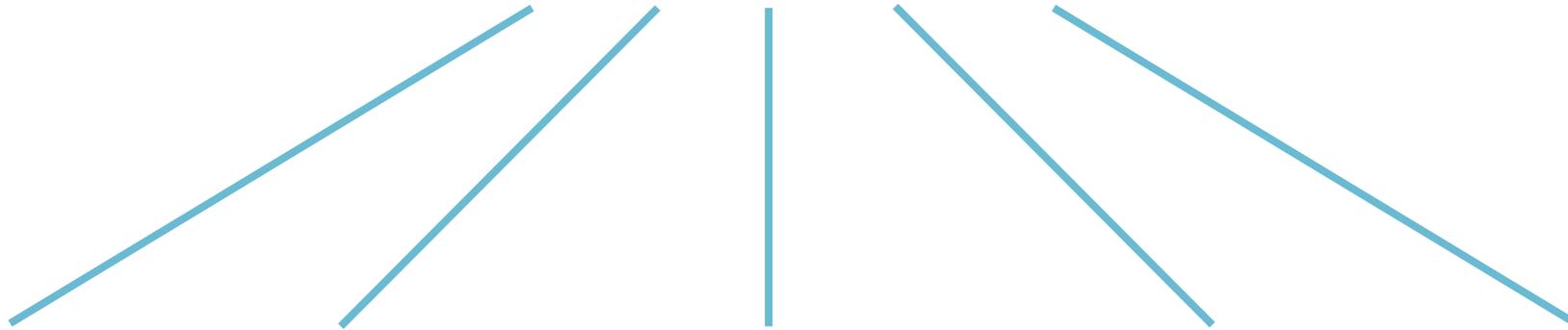


EXAMPLE: BOTTLING OF WATER



SUSTAINABLE POLYMERS – WHICH OPTIONS?

CIRCULARITY



**RESOURCE
RECOVERY**



**PRODUCT
TAKE-BACK**



REUSE



**PRODUCT
AS-A-SERVICE**



**DESIGN FOR
CIRCULARITY**

CIRCULARITY - PRODUCT TAKE-BACK



10XL

Op de producten van 10XL zit 'statiegeld'. Dit geldt krijgen bedrijven terug bij inname.



KETER[®]

Het aanbieden van 'inzameldagen' om producten terug te nemen (Keter)

CIRCULARITY - REUSE



Refill van bierflesje



Reuse van bierkratje



Eten dat wordt besteld via DeliverZero komt in een herbruikbare verpakking (Ozarka)

CIRCULARITY - PRODUCT AS-A-SERVICE (ACCESS)

Meest gekozen

Miele Wassen Classic

Geen toeters en bellen!



Max 7KG
1400 toeren /min
extra programma's
TwinDos

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Nieuw - jong gebruikt
€13.95 per maand
+ Stapeltarief per wasje ⓘ [Kies](#)

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Abonnement op kunstbloemen

CIRCULARITY - DESIGN FOR CIRCULARITY

- Design for disassembly
- Design for recycling
- Design for durability and performance
- Design for standardisation
- Less material usage



Verminderen van materiaal: Smyle tandpasta



Verwisselbare batterij in telefoon



Producten met detecteerbaar zwart voor recycling



Standaardisering van oplaadkabels: USB-C



Versterken kritische punten (zitting)

**Improving one
aspect should not
make things worse
for another**

HOW DO YOU MAKE SUSTAINABILITY CHOICES?

MATERIAL & VALUE FLOW MAP – LIFE CYCLE THINKING



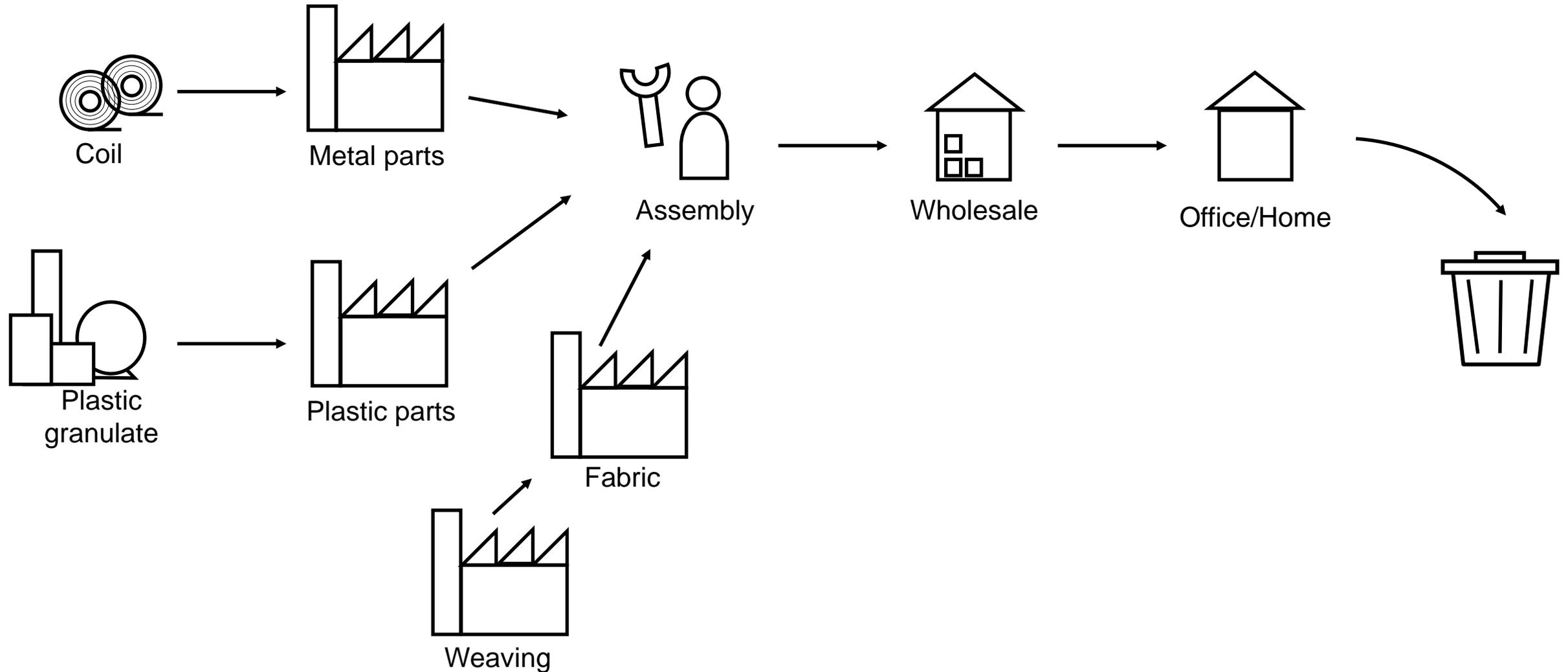
MATERIAL & VALUE FLOW MAP



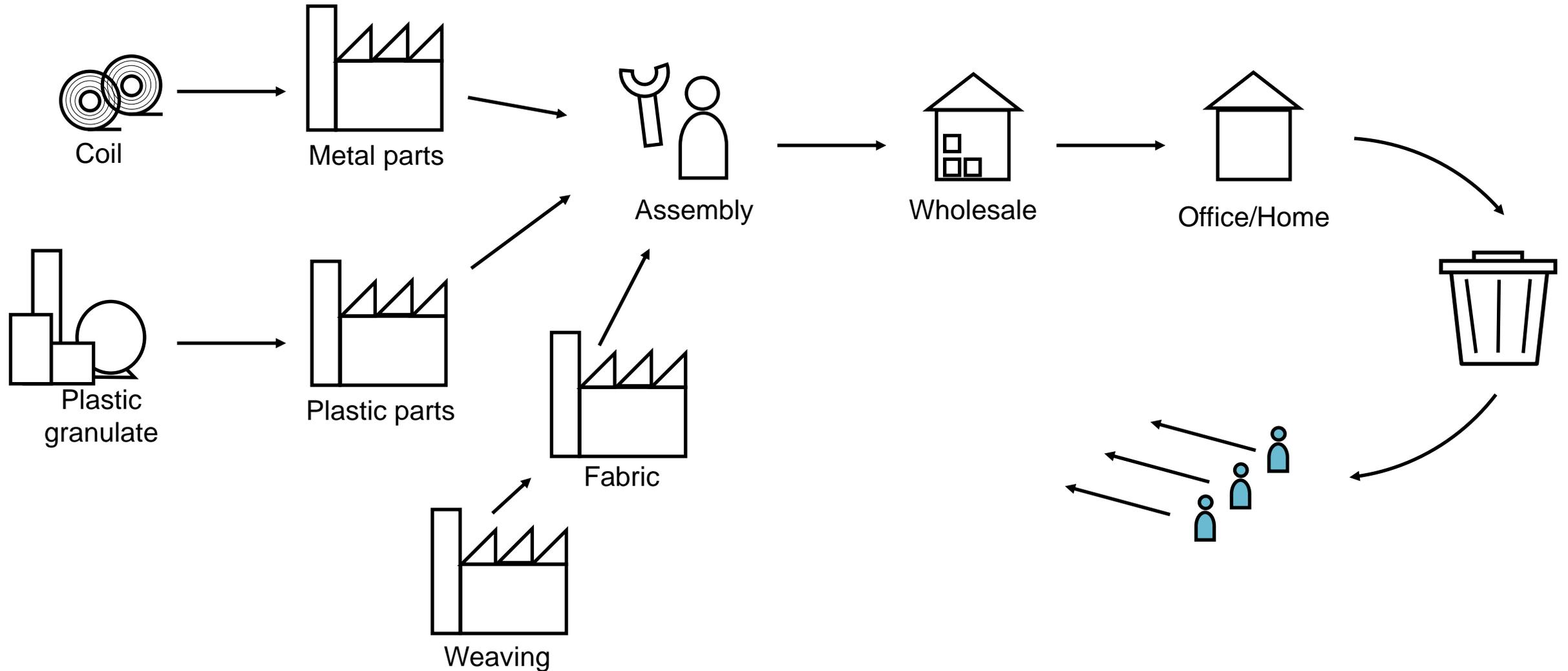
→ linear material flow

..... value flow

EXAMPLE: OFFICE CHAIR



EXAMPLE: CIRCULAR (?) OFFICE CHAIR



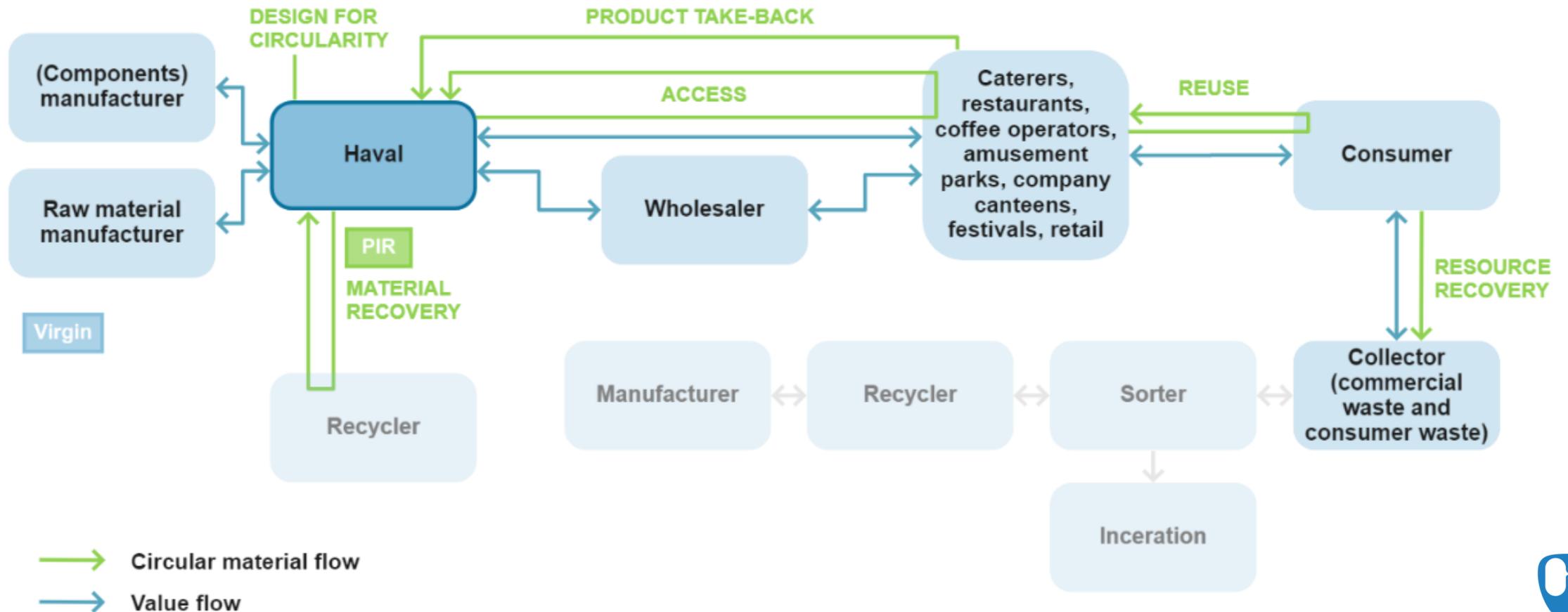
EXAMPLE: HAVAL



Products designed with as little material as possible

Circular reusable containers, designed to last long

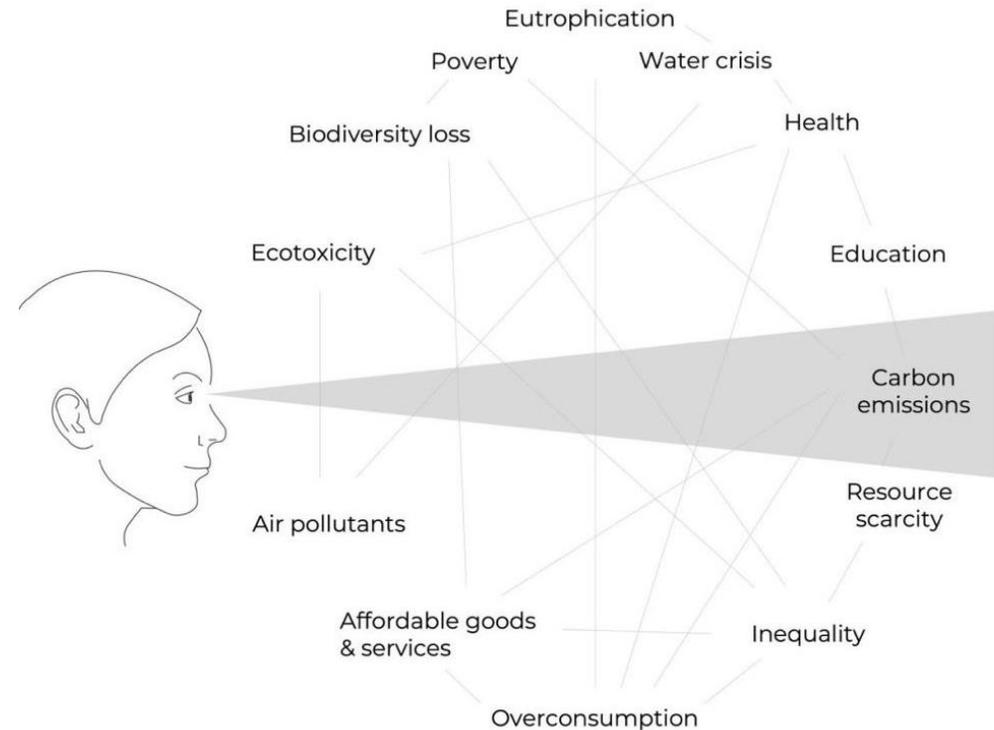
EXAMPLE: HAVAL



MATERIAL & VALUE FLOW MAPPING – WHY?



Source: Procelijn, 2017



Sustainability transition

Source: Konietzko, 2017

MATERIAL & VALUE FLOW MAPPING – WHY?

- Provides an **overview of the complete value chain**
 - Not just a focus on ‘visible impact’: materials, or usage
- A way to **explore opportunities for circularity** with other stakeholders
 - Not just focus on circularity within company
- Shows **where in the chain problems** may arise
 - To check whether a certain change also (negatively) affects other parts of the chain

CASE STUDY METHOD CIRCULAR BUSINESS MODELS

1

**Circularity of
the business
model**

2

**Circularity
in the
chain**

3

**Circularity of
operational
process**

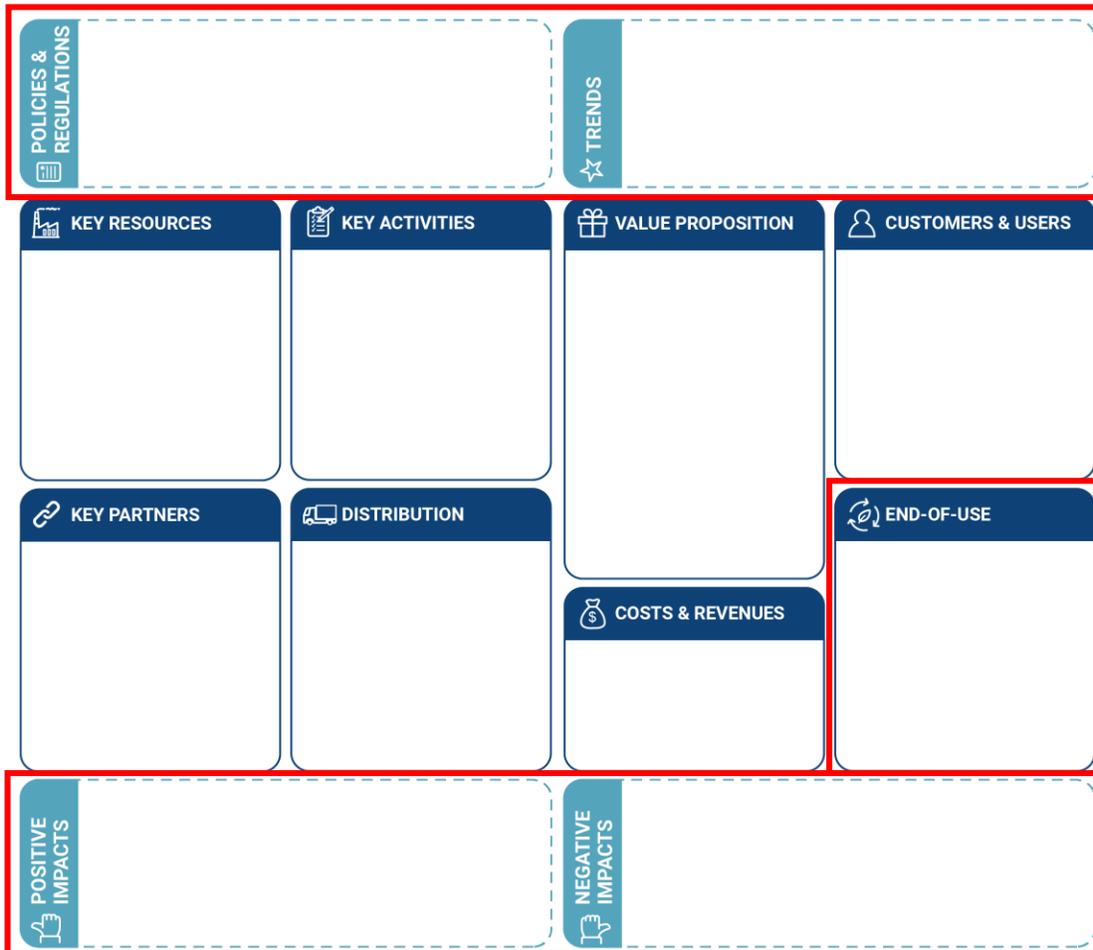
CASE STUDY METHOD

1) CIRCULARITY OF BUSINESS MODEL

<p>Key Partners </p> <p>Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?</p> <p>MOTIVATIONS FOR PARTNERSHIPS Optimization and economy Reduction of risk and uncertainty Acquisition of particular resources and activities</p>	<p>Key Activities </p> <p>What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams?</p> <p>CATEGORIES Production Problem Solving Platform/network</p>	<p>Value Propositions </p> <p>What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying?</p> <p>SMARTER/SMIES Newness Performance Customization "Getting the Job Done" Design Brand/Status Price Cost Reduction Risk Reduction Accessibility Convenience/Usability</p>	<p>Customer Relationships </p> <p>What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they?</p> <p>EXAMPLES Personal assistance Dedicated Personal Assistance Self Service Automated Services Communities Co-creation</p>	<p>Customer Segments </p> <p>For whom are we creating value? Who are our most important customers?</p> <p>Mass Market niche Market Segmented Diversified Multi-sided Platform</p>																
<p>Cost Structure </p> <p>What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?</p> <p>IS YOUR BUSINESS MORE Cost Driven (focused cost structure, low price value proposition, maximum automation, extensive outsourcing) Value Driven (focused on value creation, premium value proposition)</p> <p>USUAL CHARACTERISTICS Fixed Costs (salaries, rents, utilities) Variable costs Economies of scale Economies of scope</p>	<p>Key Resources </p> <p>What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?</p> <p>TYPES OF RESOURCES Physical Intellectual (brand, patents, copyrights, data) Human Financial</p>	<p>Channels </p> <p>Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?</p> <p>CHANNEL PHASES 1. Awareness How do we raise awareness about our company's products and services? 2. Evaluation How do we help customers evaluate our organization's Value Proposition? 3. Purchase How do we allow customers to purchase specific products and services? 4. Delivery How do we deliver a Value Proposition to customers? 5. After sales How do we provide post-purchase customer support?</p>	<p>Revenue Streams </p> <p>For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues?</p> <table border="0"> <tr> <td>FIXED PRICING</td> <td>DYNAMIC PRICING</td> </tr> <tr> <td>Asset sale</td> <td>Regulation (Bar-gaining)</td> </tr> <tr> <td>Usage fee</td> <td>Product Feature dependent</td> </tr> <tr> <td>Subscription fees</td> <td>Customer segment dependent</td> </tr> <tr> <td>Lending/Renting/leasing</td> <td>Real-time Market</td> </tr> <tr> <td>Licensing</td> <td>Volume dependent</td> </tr> <tr> <td>Divestiture fees</td> <td></td> </tr> <tr> <td>Advertising</td> <td></td> </tr> </table>	FIXED PRICING	DYNAMIC PRICING	Asset sale	Regulation (Bar-gaining)	Usage fee	Product Feature dependent	Subscription fees	Customer segment dependent	Lending/Renting/leasing	Real-time Market	Licensing	Volume dependent	Divestiture fees		Advertising		
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CASE STUDY METHOD

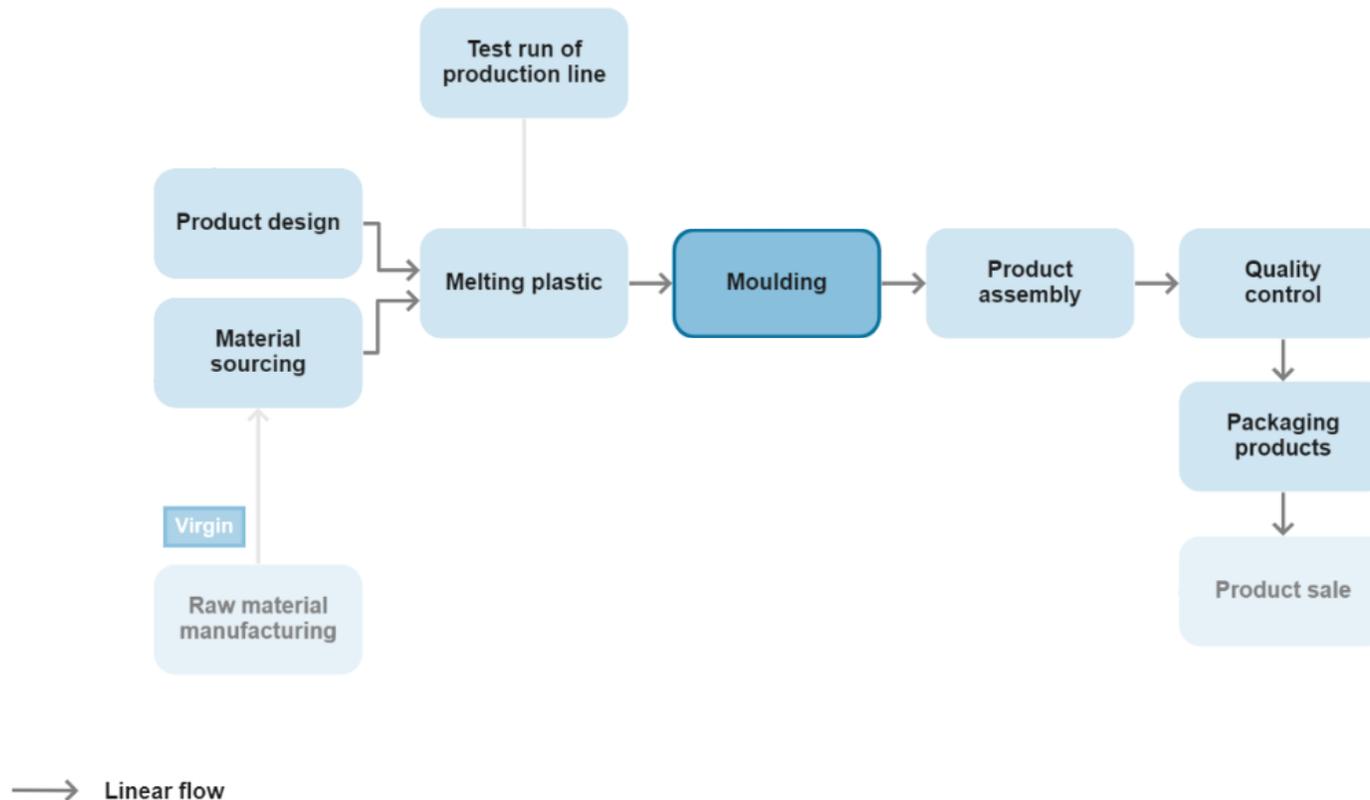
1) CIRCULARITY OF BUSINESS MODEL



- Focus on circularity
- Includes return flows
- Not only customers, but also end-users
- End-of-life of products
- Context: regulations & trends
- Positive & negative impacts on environment and society

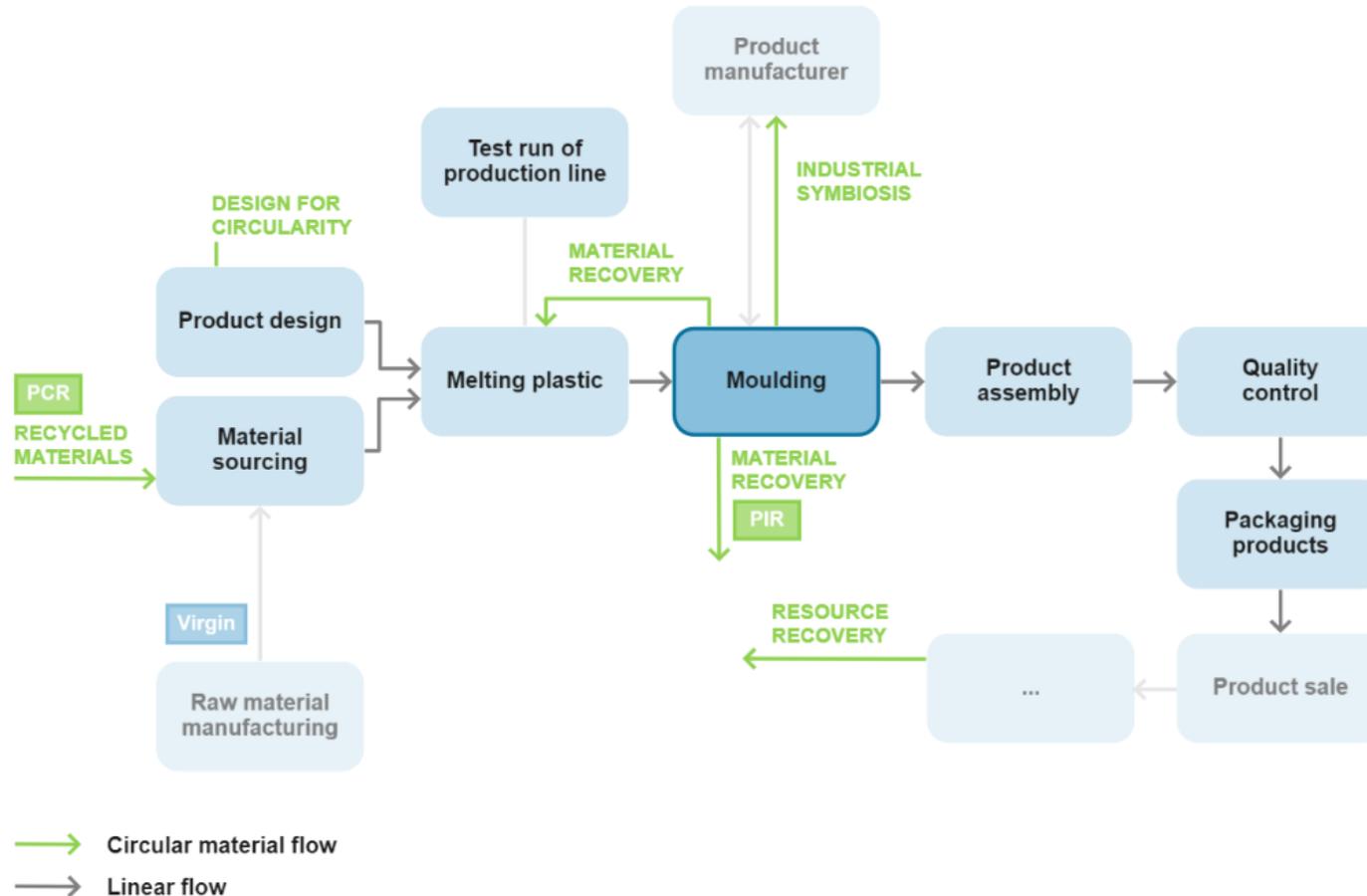
CASE STUDY METHOD

3) CIRCULARITY OF OPERATIONAL PROCESS

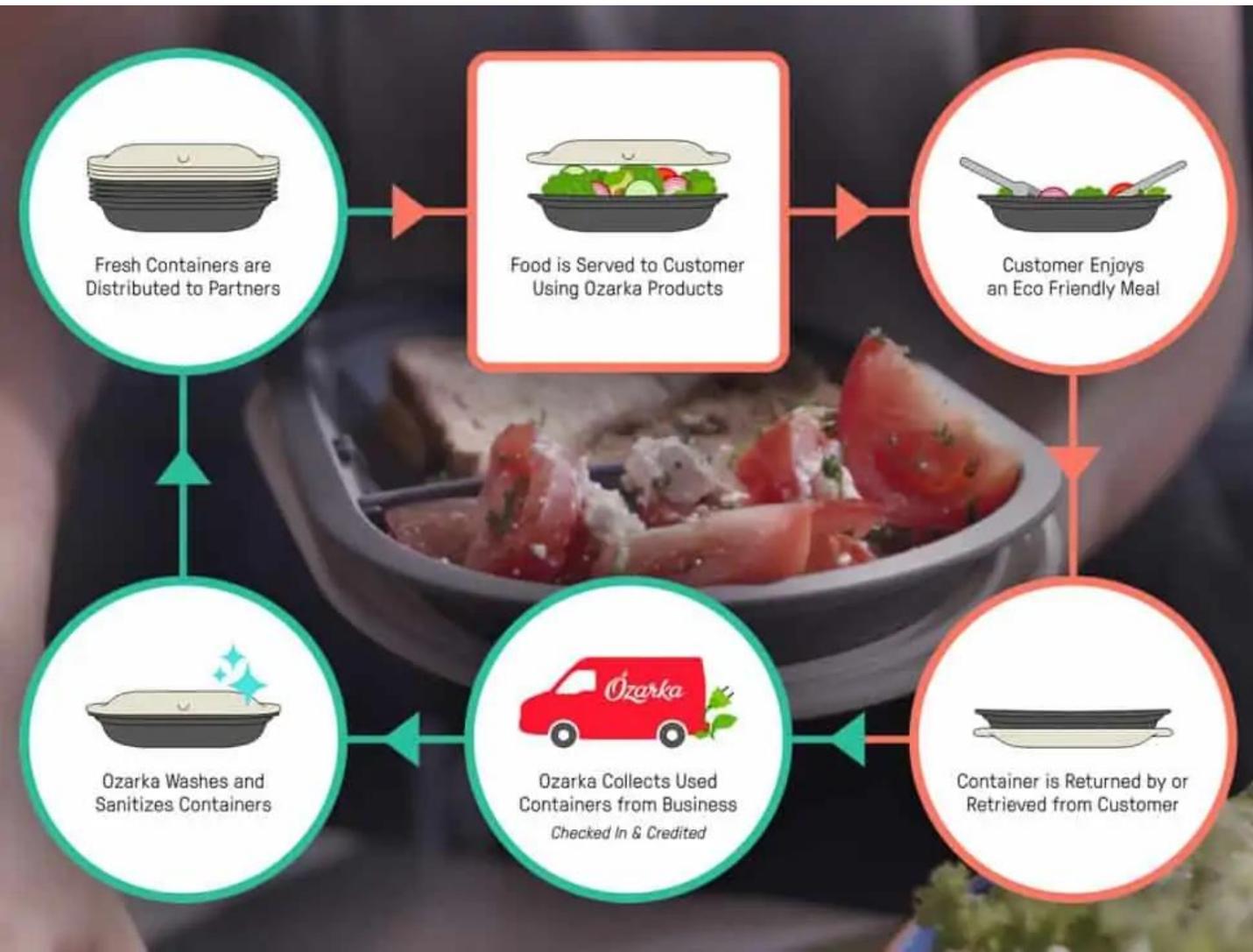


CASE STUDY METHOD

3) CIRCULARITY OF OPERATIONAL PROCESS

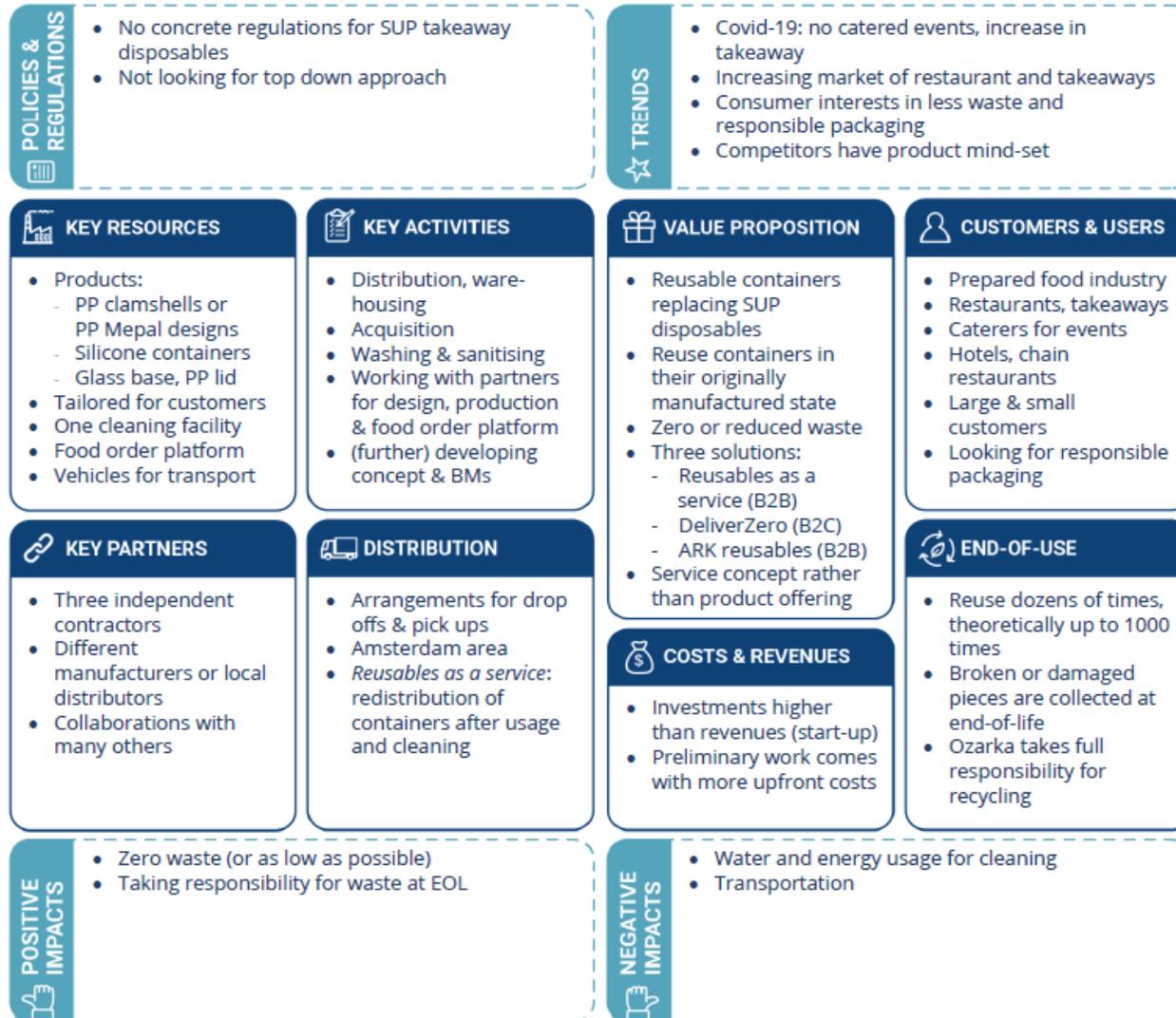


EXAMPLE: OZARKA

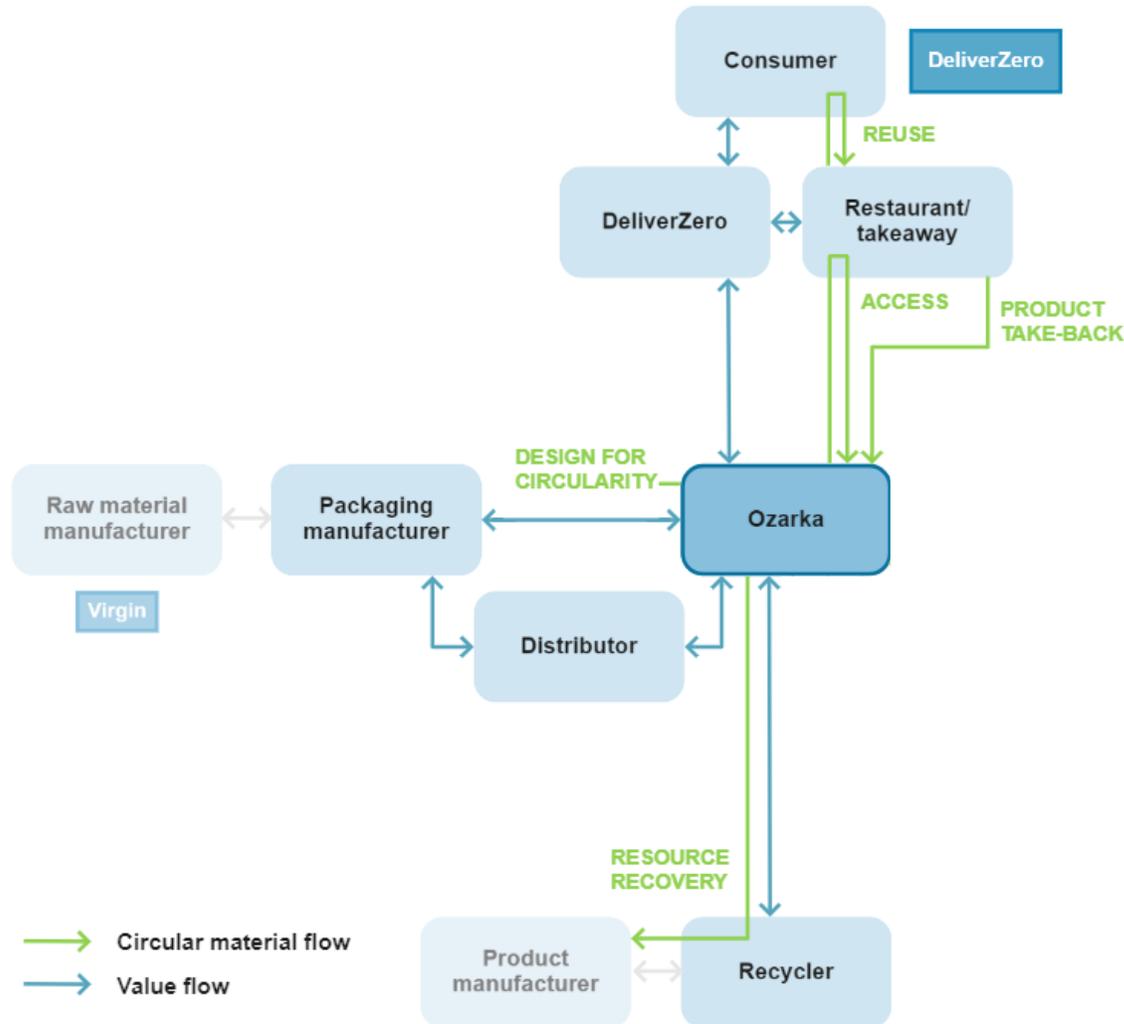


Ozarka

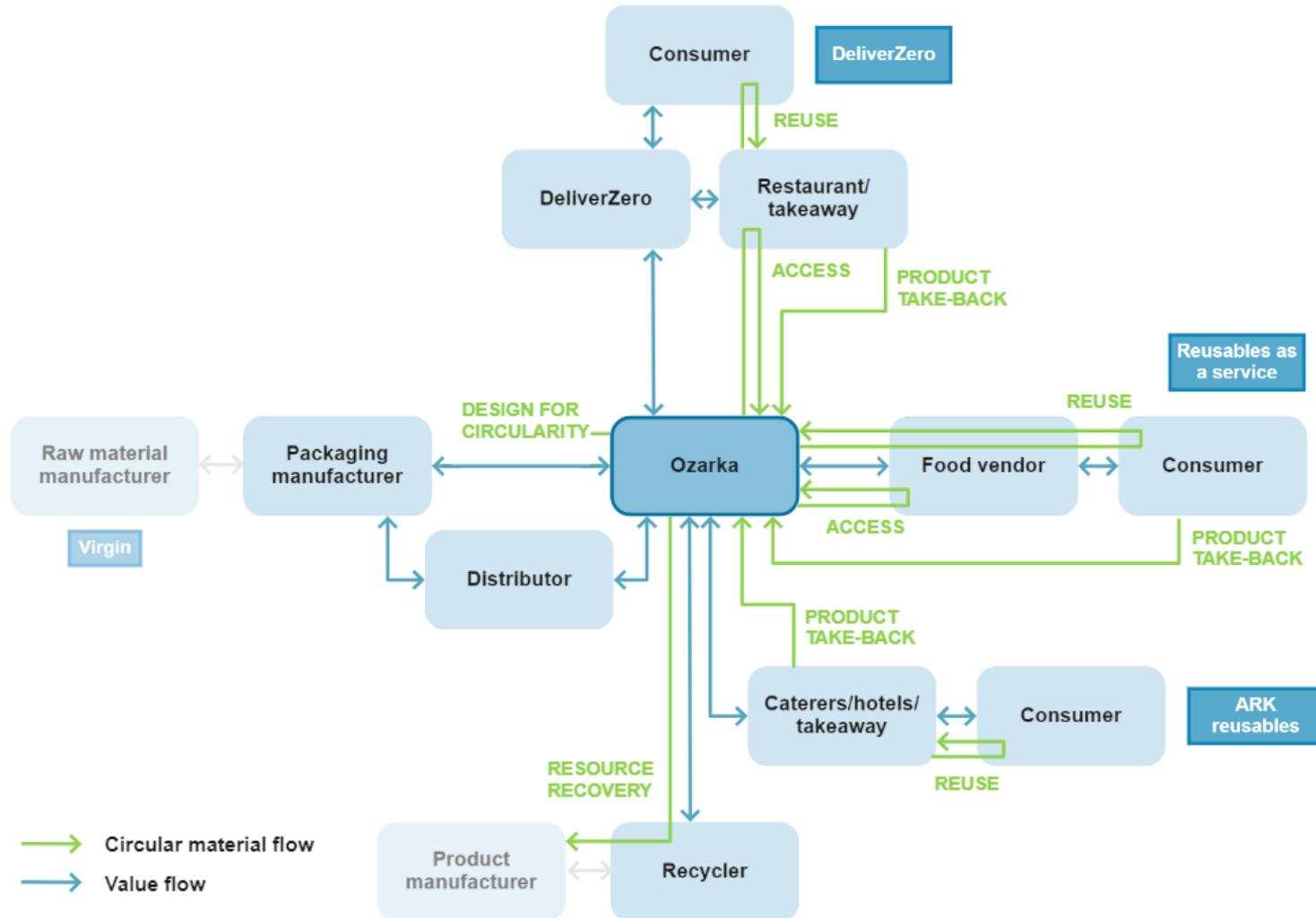
EXAMPLE: OZARKA – CIRCULAR BUSINESS MODEL



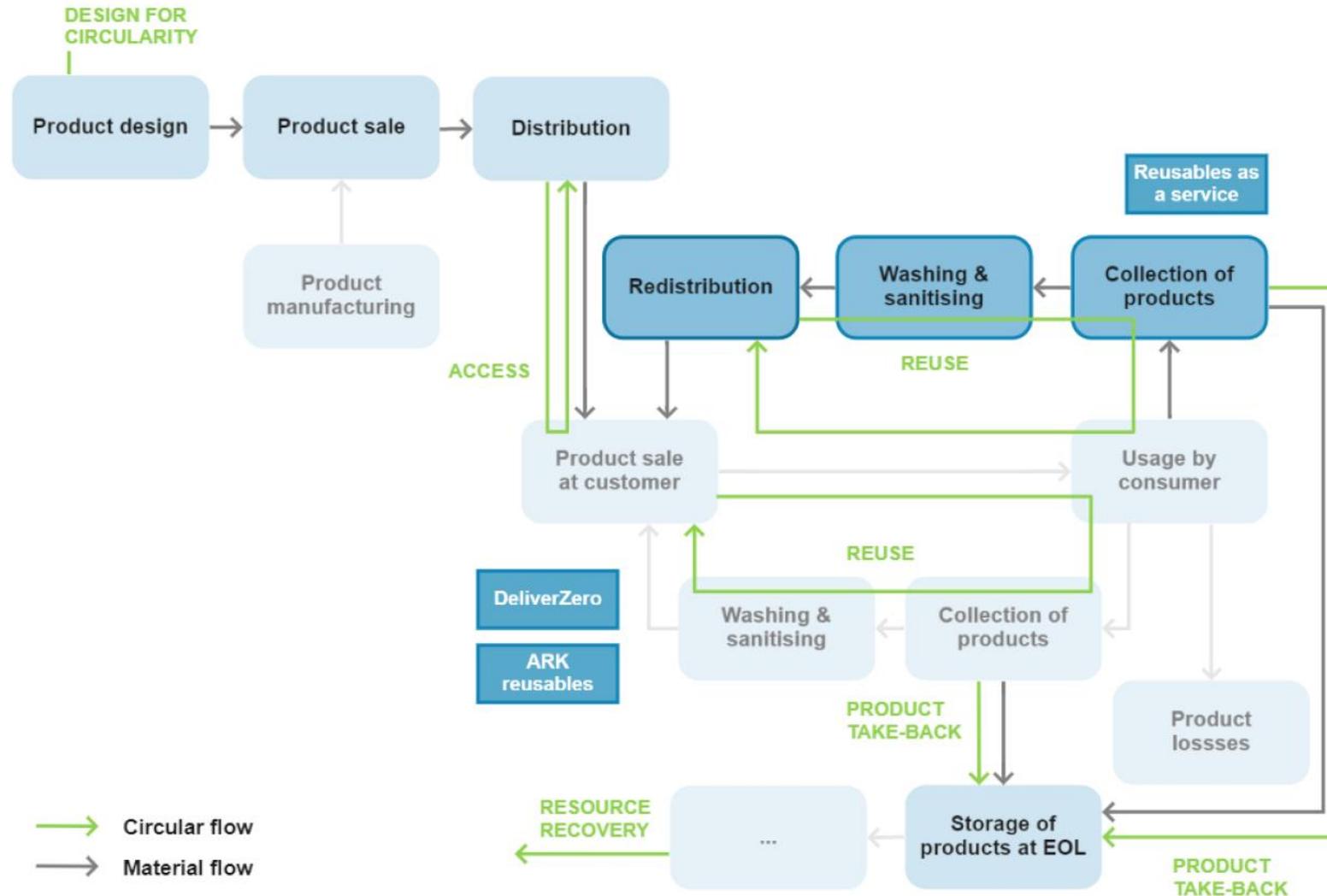
EXAMPLE: OZARKA – CIRCULARITY IN THE CHAIN



EXAMPLE: OZARKA – CIRCULARITY IN THE CHAIN



EXAMPLE: OZARKA – OPERATIONAL CIRCULARITY



RECAP

WHY DO WE USE PACKAGING?

SUSTAINABLE OPTION DEPENDS ON:

- Product
- Context
- Use

BUT: There is not one most sustainable packaging solution

SUSTAINABLE POLYMERS – WHICH OPTIONS?

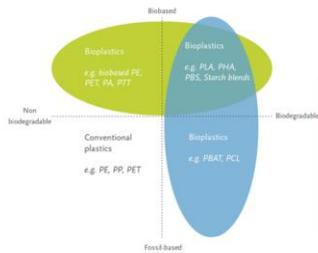


PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY RESULTS: 1) BARRIERS & ENABLERS



Source: Van der Vegt et al., 2021

BIOPLASTICS – BIOBASED VS. BIODEGRADABLE



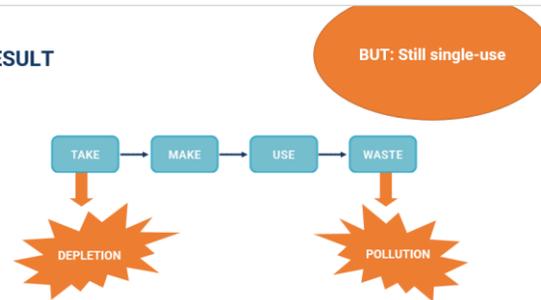
Biobased: the material is obtained from biomass (plants, e.g. sugar cane, maize, starch). This is about the origin of the material.

Biodegradable: the material breaks down under specific conditions. This is about what happens to the material at end-of-life.

Biobased ≠ Biodegradable

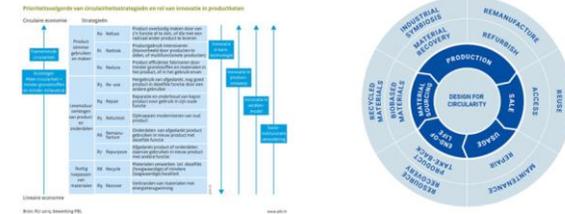
European Bioplastics

RESULT



Source: Wöhring et al., 2021

CIRCULARITY - CIRCULAR STRATEGIES



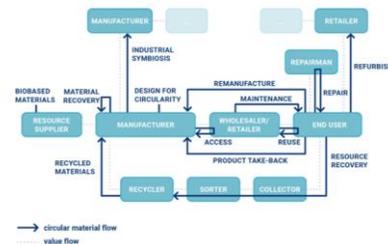
Source: Pöhl, 2019

Source: Van der Vegt et al., 2021

Improving one aspect should not make things worse for another

HOW DO YOU MAKE SUSTAINABILITY CHOICES?

CIRCULAR MATERIAL & VALUE FLOW MAP



Source: Van der Vegt et al., 2021

CASE STUDY METHOD CIRCULAR BUSINESS MODELS

1. Circularity of the business model
2. Circularity in the chain
3. Circularity of operational process

PLASTIC FANTASTIC TRUCK TOUR

- Tuesday 11th of October
- 11.30 - 15.30 hr
- HL7, back-side (Cambridgelaan)

