CIRCULAR DESIGN FORUM

Circular, **together!**

CIRCULAR DESIGN FORUM

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Fraunhofer

CIRCONNECT

Life Cycle Design

Definition

Life-Cycle Design is the environmentally sound design of products based on the whole lifecycle starting from exploitation and processing of raw materials, preproduction, production, distribution, to use and returning materials back into the industrial cycles.

Life Cycle Design, blocks

Content of exploration

Current status in design practice

Framework to scope Life Cycle Design elements

Applying the framework for two sectors

Conclusions and subject for further debate

Life Cycle Design, blocks

Two subjects for this exploratory session

How do designers (= you) apply Life Cycle Design in their daily practice?

Validation of integrale design model on Life Cycle / circular design?

Life Cycle Design

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Let's dive into LCD and have a quick brainstorm!

Pick a product (couch or consumer electronics) and discuss the following questions:

1. End-of-life: what is necessary to take it apart and reuse as much of the product as possible? What makes it easy / difficult?

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3. Pre-use-phase (production): what design decisions are made that create these possibilities and difficulties?

Life Cycle Design

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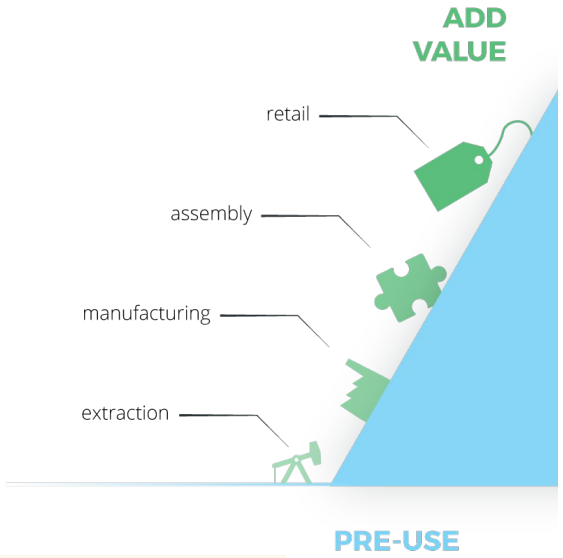
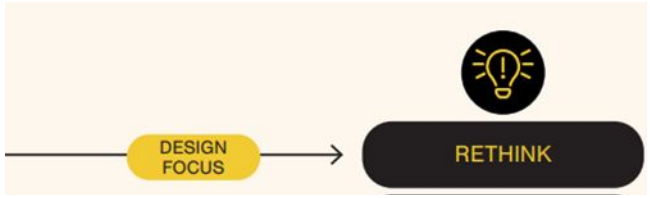
Introduction framework

Framework circular design, introduction

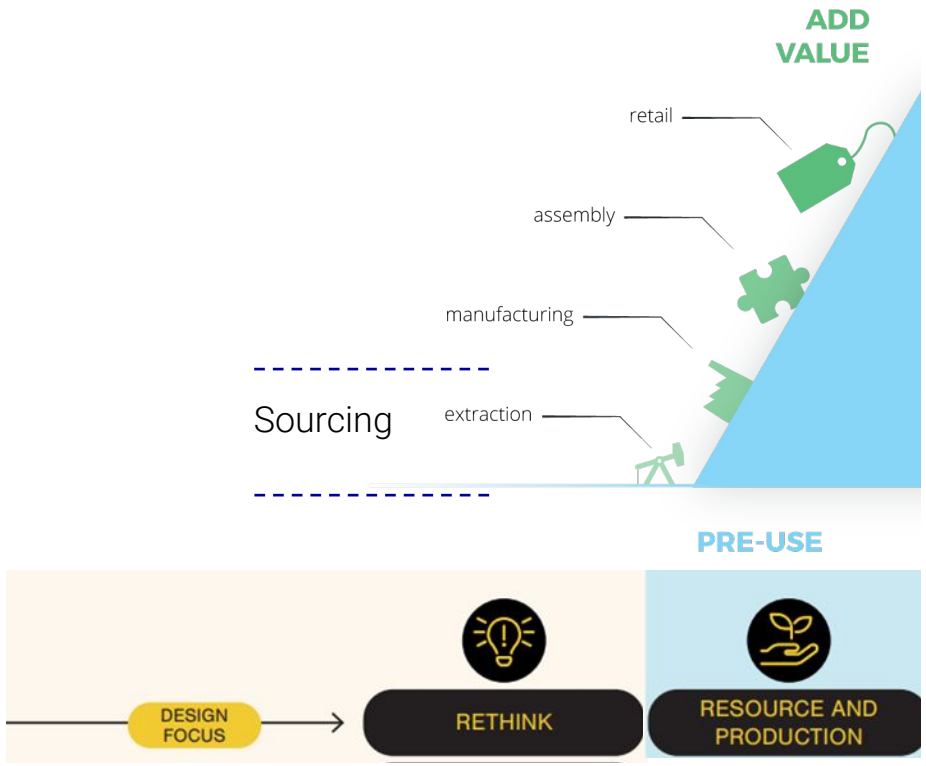




System level

- → Innovation for system level sustainability
- → Several products consolidated
- → Shared product use
- → Alternative product / packaging solution

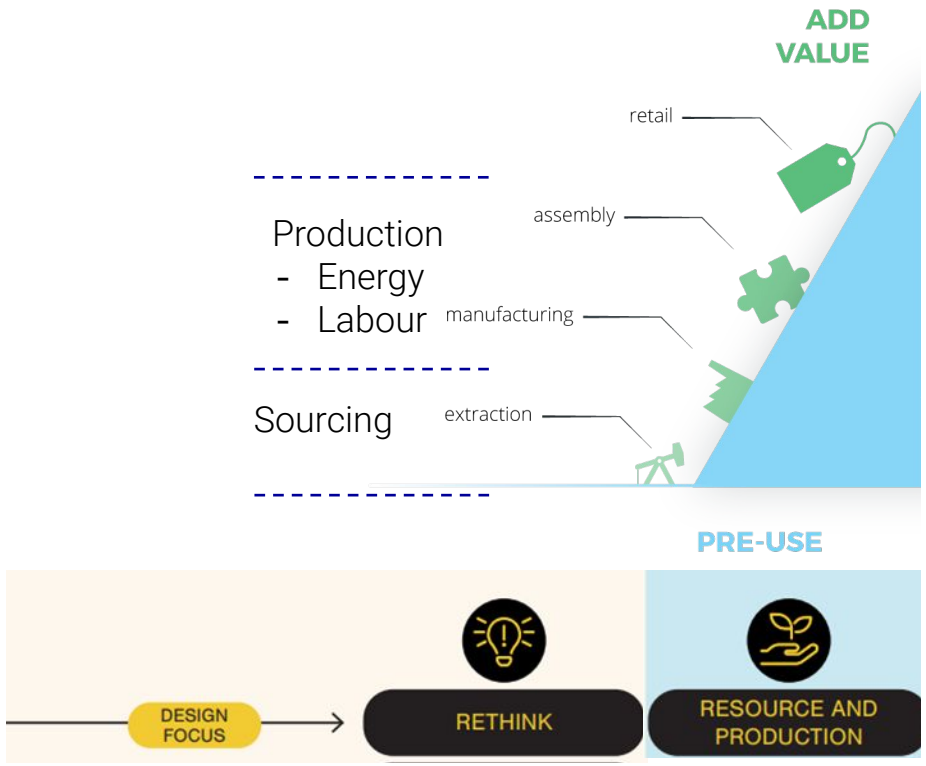
Framework circular design, introduction



Low-impact materials

- → Responsibly sourced
- → Recycled
- → Rapidly renewable
- → Recyclable
- → Save (no substances of concern)
- → Minimal amount of material
- → Bio-materials (?)

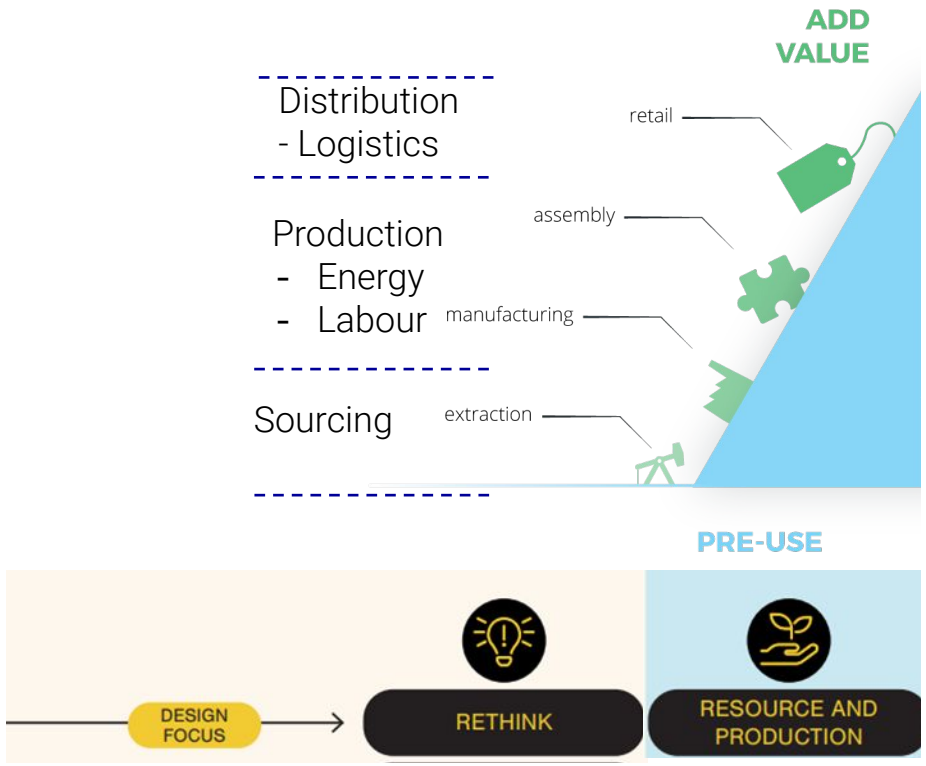
Framework circular design, introduction



Clean manufacturing

- → Efficient and safe
- → Less and renewable energy
- → Efficient software development

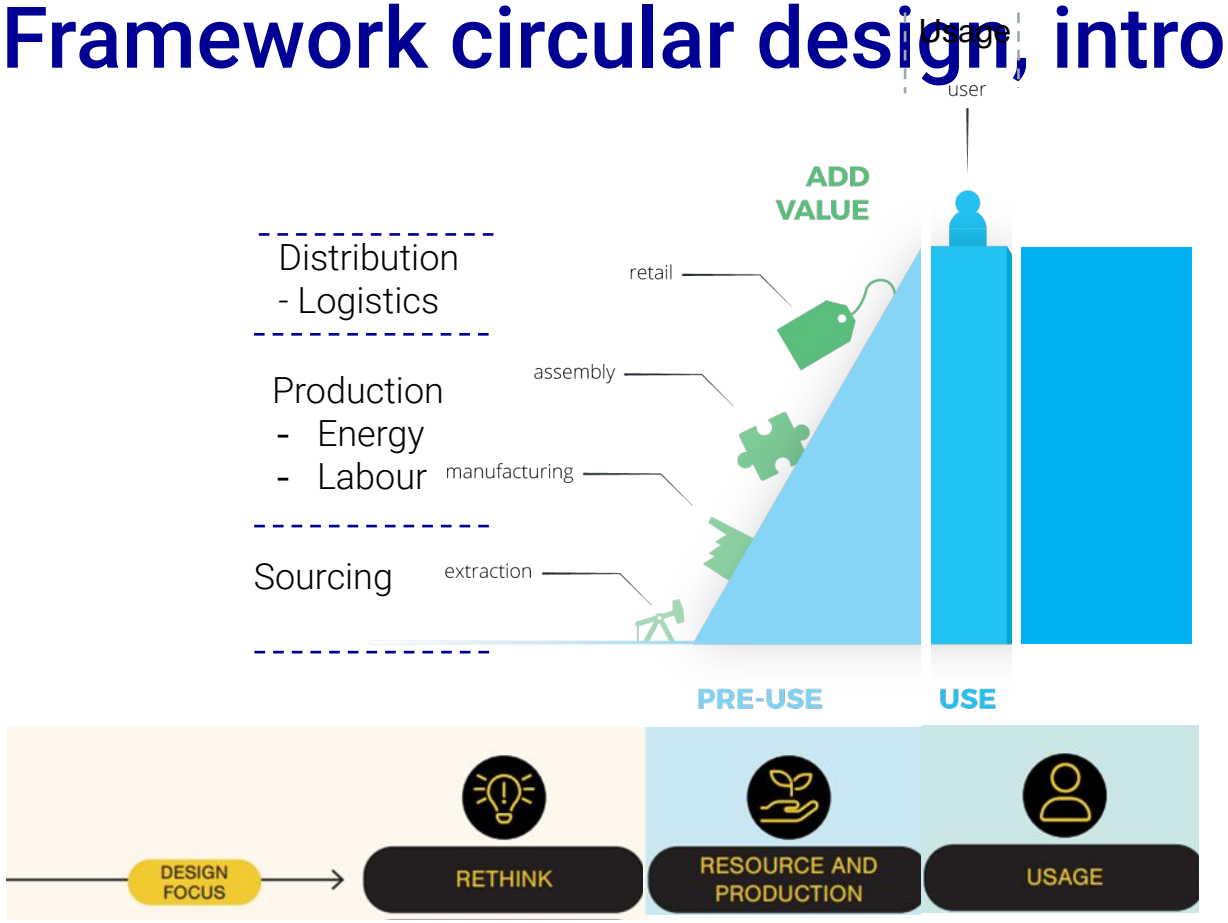
Framework circular design, introduction



Efficient distribution and packaging

- → Lightweighting
- → Energy efficient logistics
- → Reduced volume packaging
- → Less/cleaner/reusable packaging
- → Recycled material

Framework circular design, introduction



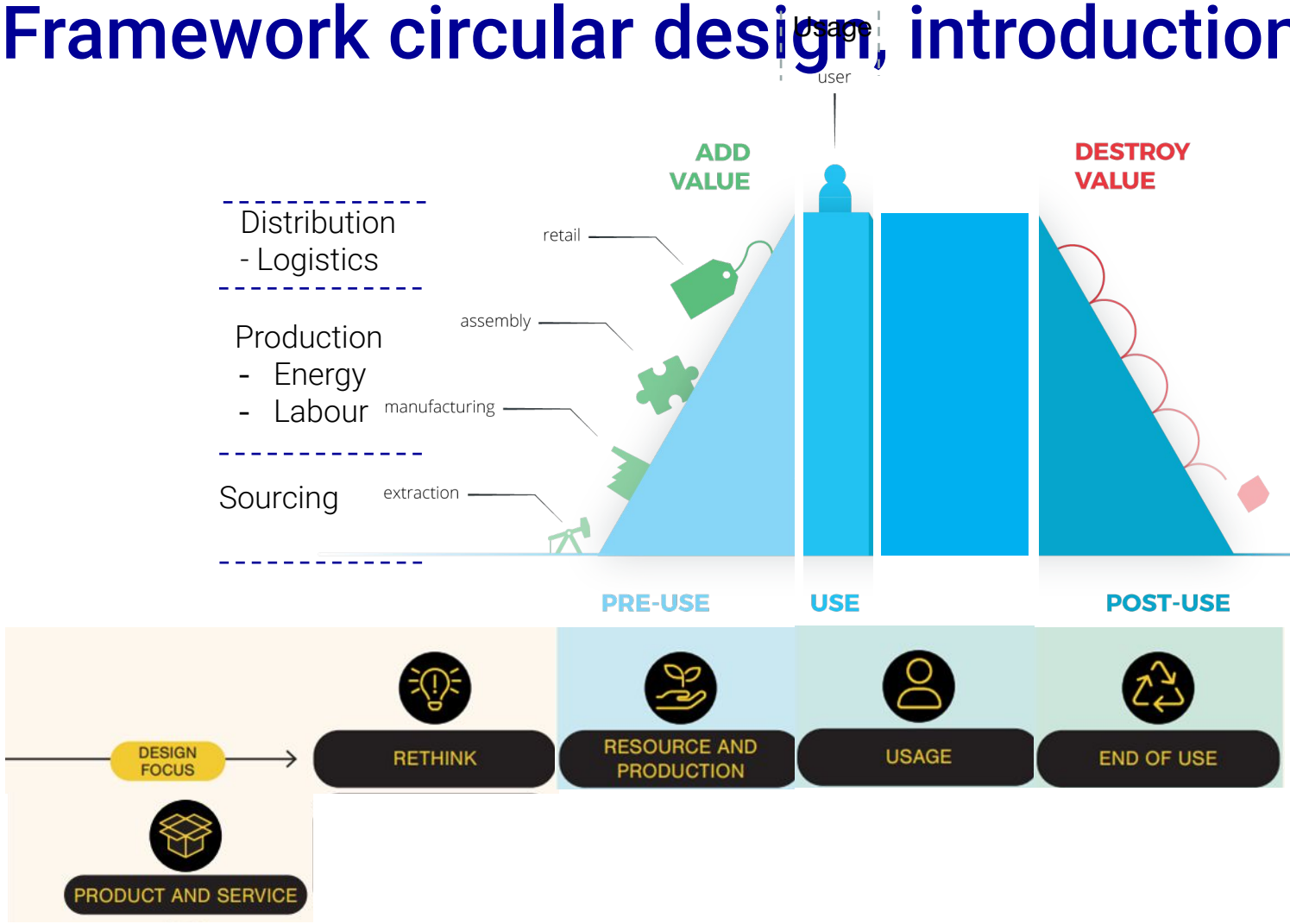
Use efficiency

- → Minimize power / fuel
- → Minimize indirect energy loss
- → Efficient/ clean use of consumables
- → Efficient/clean use of auxiliary materials

Extended use

- → Reliability and durability
- → Upgradability and compatibility
- → Ease of maintenance and repair
- → Aging gracefully
- → Prevented premature obsolescence

Framework circular design, introduction



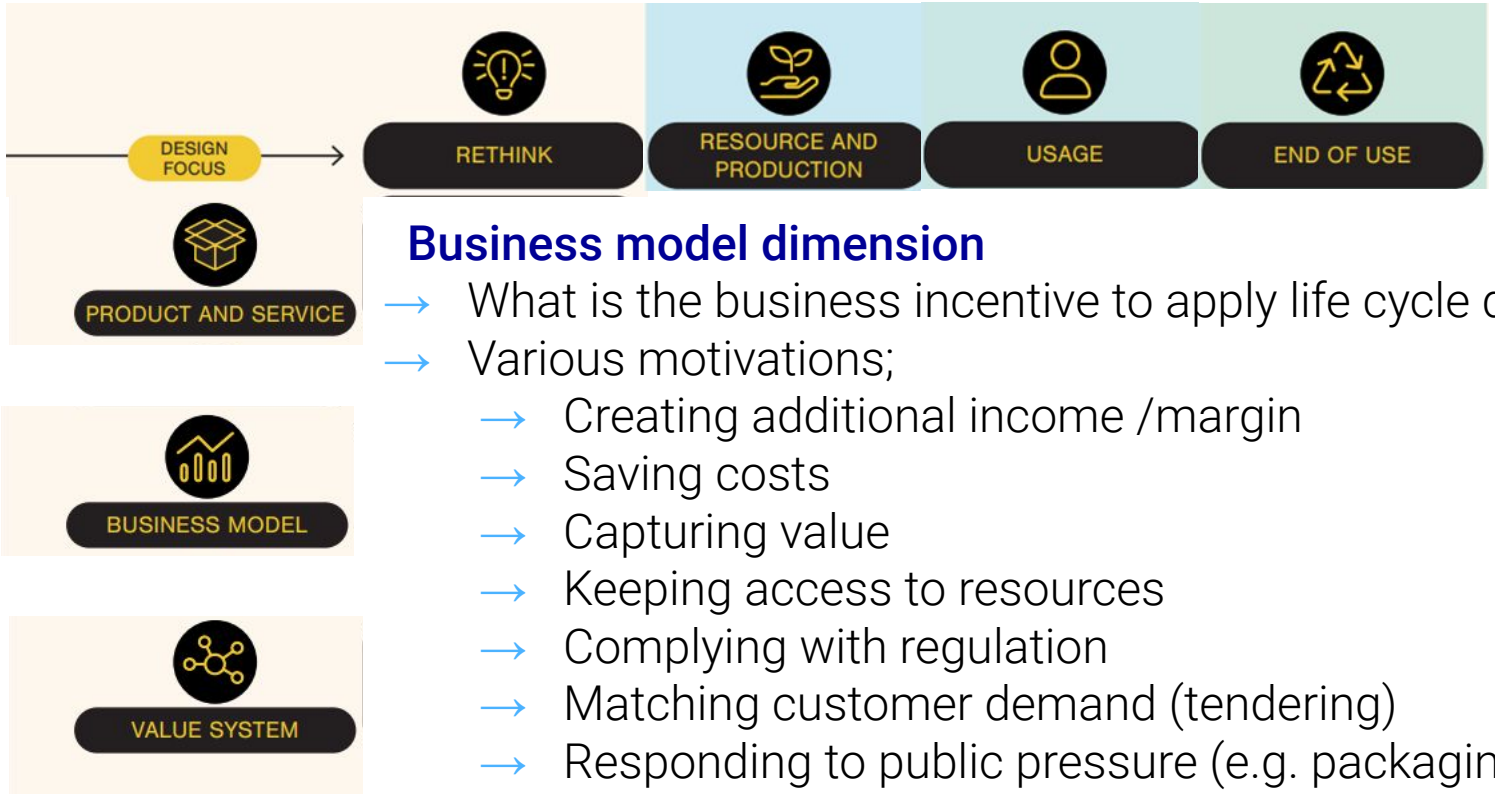
Recovery for reuse

- Reuse direct of repurpose)
- Refurbishment
- Remanufacturing
- Part harvesting

End of life

- Mechanical recycling
- Chemical recycling
- Composting
- Incineration (?)

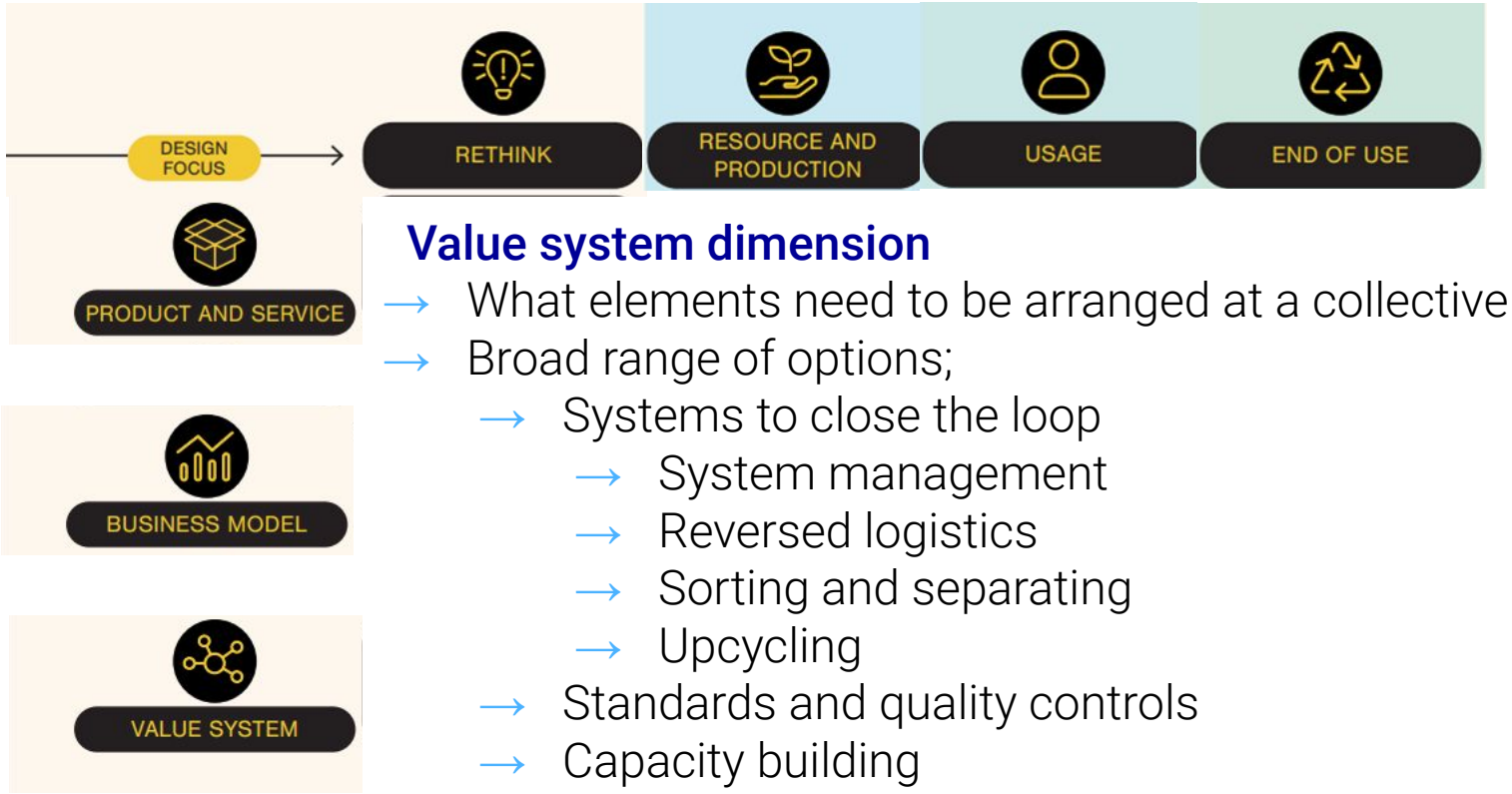
Business model dimension



Business model dimension

- What is the business incentive to apply life cycle design?
- Various motivations;
  - Creating additional income /margin
  - Saving costs
  - Capturing value
  - Keeping access to resources
  - Complying with regulation
  - Matching customer demand (tendering)
  - Responding to public pressure (e.g. packaging)
- Should compensate for additional investment / effort / risk

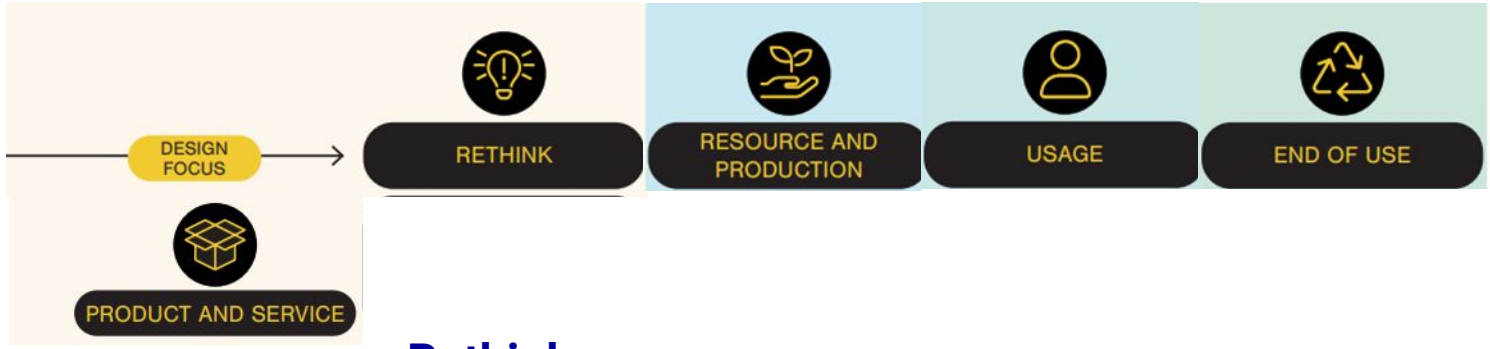
Value system dimension



Value system dimension

- What elements need to be arranged at a collective level?
- Broad range of options;
  - Systems to close the loop
    - System management
    - Reversed logistics
    - Sorting and separating
    - Upcycling
  - Standards and quality controls
  - Capacity building
  - Digitization
- Collaboration / coordination needed beyond individual player

Elaboration on dimensions



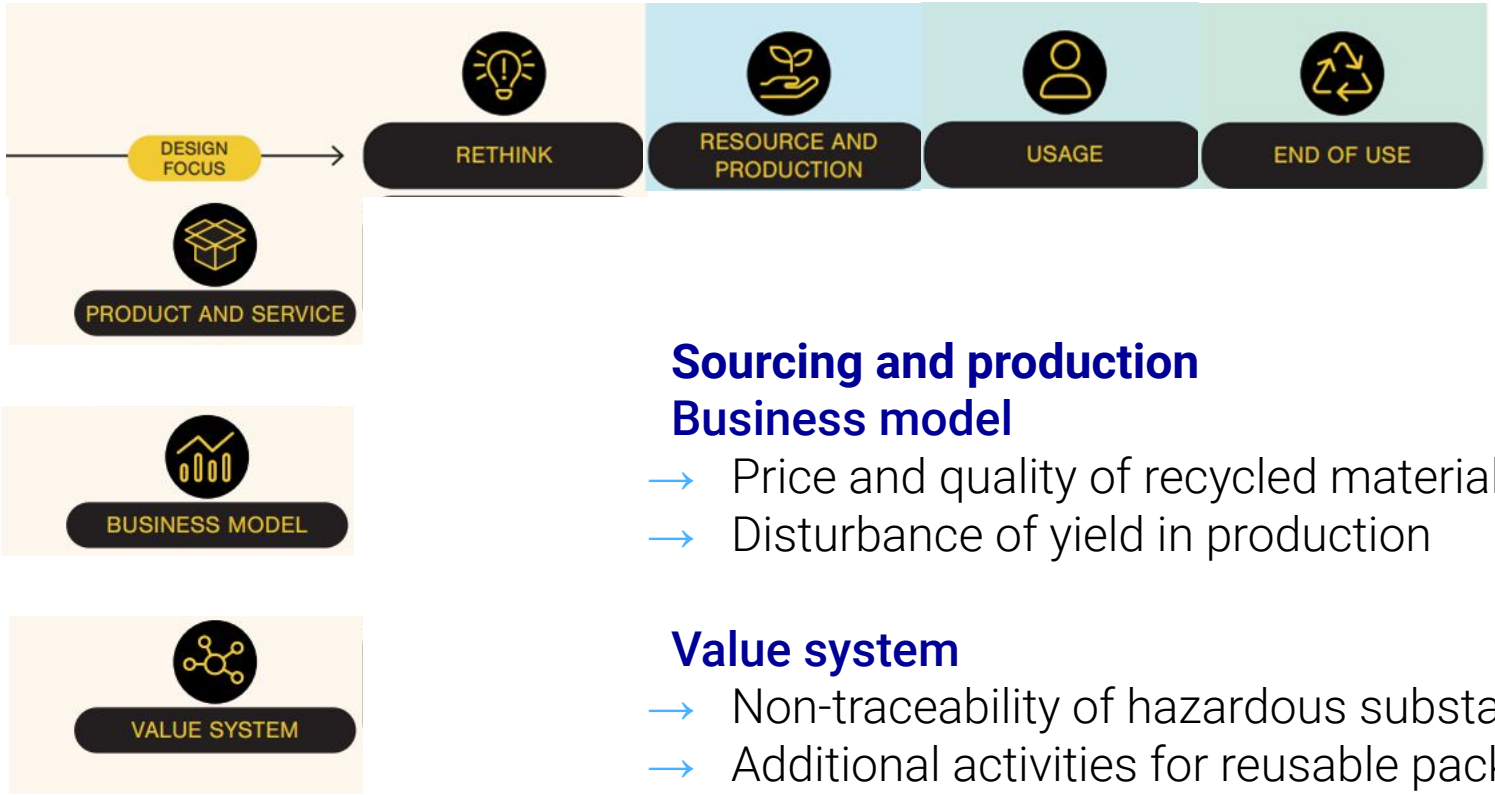
Rethink
Business model

→ Not in interest current supplier
→ Alienating current channels

Value system

→ Symbiose with other industries
→ Additional capabilities

Elaboration on dimensions



Sourcing and production

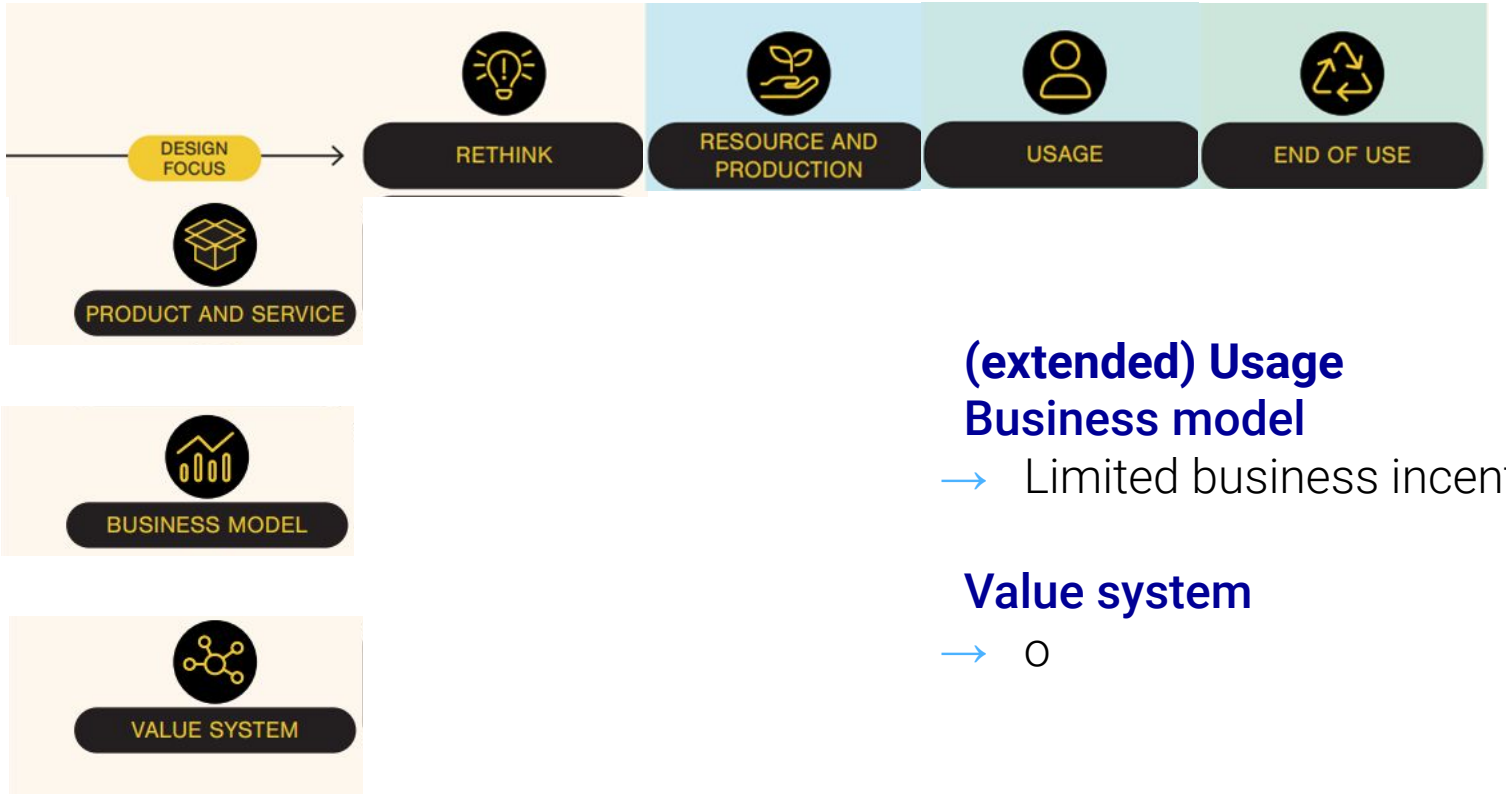
Business model

- Price and quality of recycled material
- Disturbance of yield in production

Value system

- Non-traceability of hazardous substances
- Additional activities for reusable packaging

Elaboration on dimensions



(extended) Usage

Business model

→ Limited business incentive

Value system

→ o

Elaboration on dimensions

End-of-use
Business model

- → High cost of logistics and labour
- → Low value of materials
- → Allocation costs

Value system

- → Efficient reversed loops

Interaction, round 1

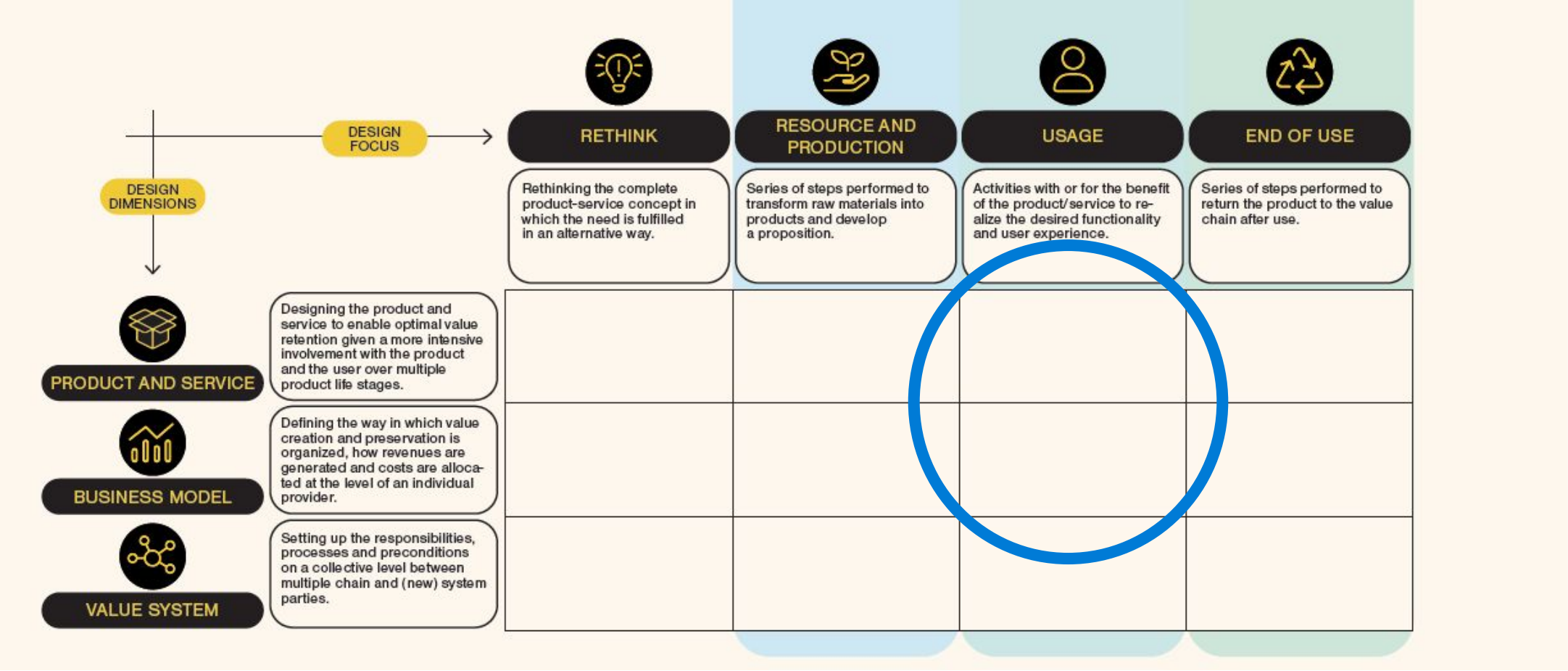
Two topics for discussion

1. Additional design dimensions

Model is not only about product and service dimension, but also about business model and value system;

- → How do you currently deal with those dimensions?
- → Is the product and service dimension covered like this?
- → Are the added dimensions (business model and value system) relevant?
- → Is it feasible and desired to add those dimensions?
- → Should all dimensions be part of the design process?
- → What are strengths and weaknesses of the method?

CIRCO practise (SME-companies)



Participant input, round 1

Two topics for discussion

2. Scoping for individual companies

In practice we observe that most designers select / pick certain cells of the model instead of fully a integral design;

- → How does your company deal with this?
- → Is ‘cherry picking’ a sensible / pragmatic approach?
- → How to select the relevant cells?
  - → Hot spot identification / mapping
  - → What role can LCA play?
- → How to address / deal with the cells not selected?

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(Design) challenges in electronic products

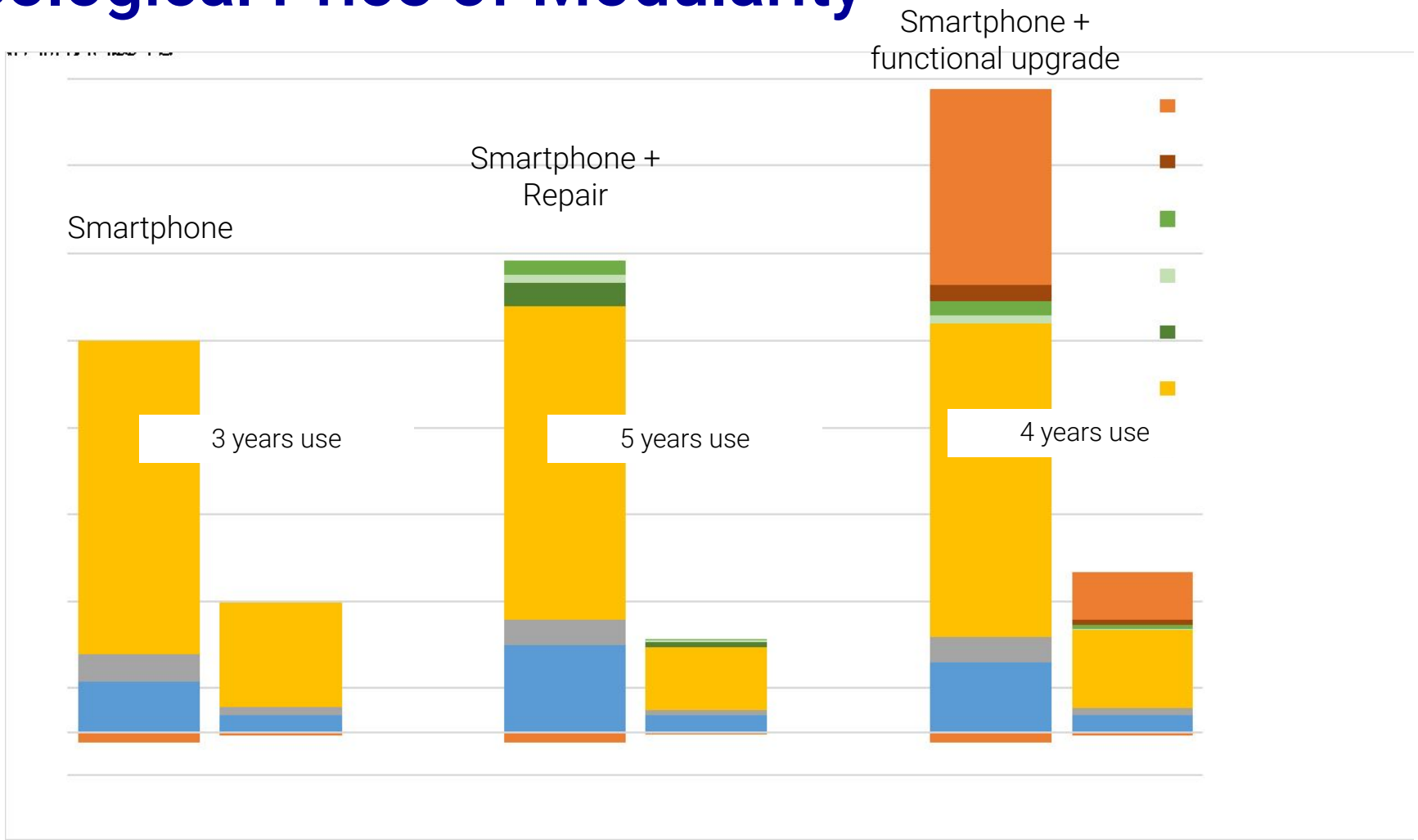
Life-cycle

LCAs of white goods

Product Group	Product Reference	GWP (%)				Source
		Production	Use	Distrib.	EOL	
Vacuum Cleaner	Reference Canister VC	26%	77%	2%	-5%	Gallego-Schmid et al. 2016
	Reference Canister VC	18%	81%	0%	1%	Bobba et a. 2015
	Reference Canister VC	9%	88%	0%	3%	Blepp et al. 2013
	Reference Hand VC	8%	89%	0%	3%	
	Reference Battery VC	28%	62%	0%	9%	
	Reference Canister VC	28%	67%	10%	-4%	Ramens et al. 2019
	Reference Cordless VC	33%	63%	7%	-4%	
	Reference Robot VC	48%	47%	6%	-1%	
Washing Machines	Reference horizontal-axis WM	25%	79%	0%	-4%	Rüdenauer et al. 2005
	Reference horizontal-axis WM	42%	74%	2%	-18%	Yuan et al. 2016
	Base Case WM	19%	81%	3%	-2%	Boyano et al. 2017
Dishwasher	Standard Dishwasher (A)	9%	91%	0%	0%	Gensch et al. 2013
	Standard Dishwasher (A+++))	13%	87%	0%	0%	
Fridge	Base Case household fridge	18%	82%	6%	-6%	VHK et al. 2016
	Base Case household fridge	12%	89%	0%	-2%	Rüdenauer et al. 2007
Kettle	Electric Kettle	7%	92%	1%	1%	Marcinkowski et al. 2017
Coffee Machine	Nespresso	40%	47%	8%	5%	Quantis 2013
	French Press	10%	88%	0%	2%	Brommer et al. 2011
	Filter drip coffee maker	14%	78%	0%	8%	
	Fully automatic coffee	6%	90%	0%	4%	
	Pad filter machine with credit	10%	86%	0%	4%	
	Capsule (PP+Alu) with credit	25%	64%	0%	12%	
	Capsule (100% Alu) with credit	25%	69%	0%	7%	

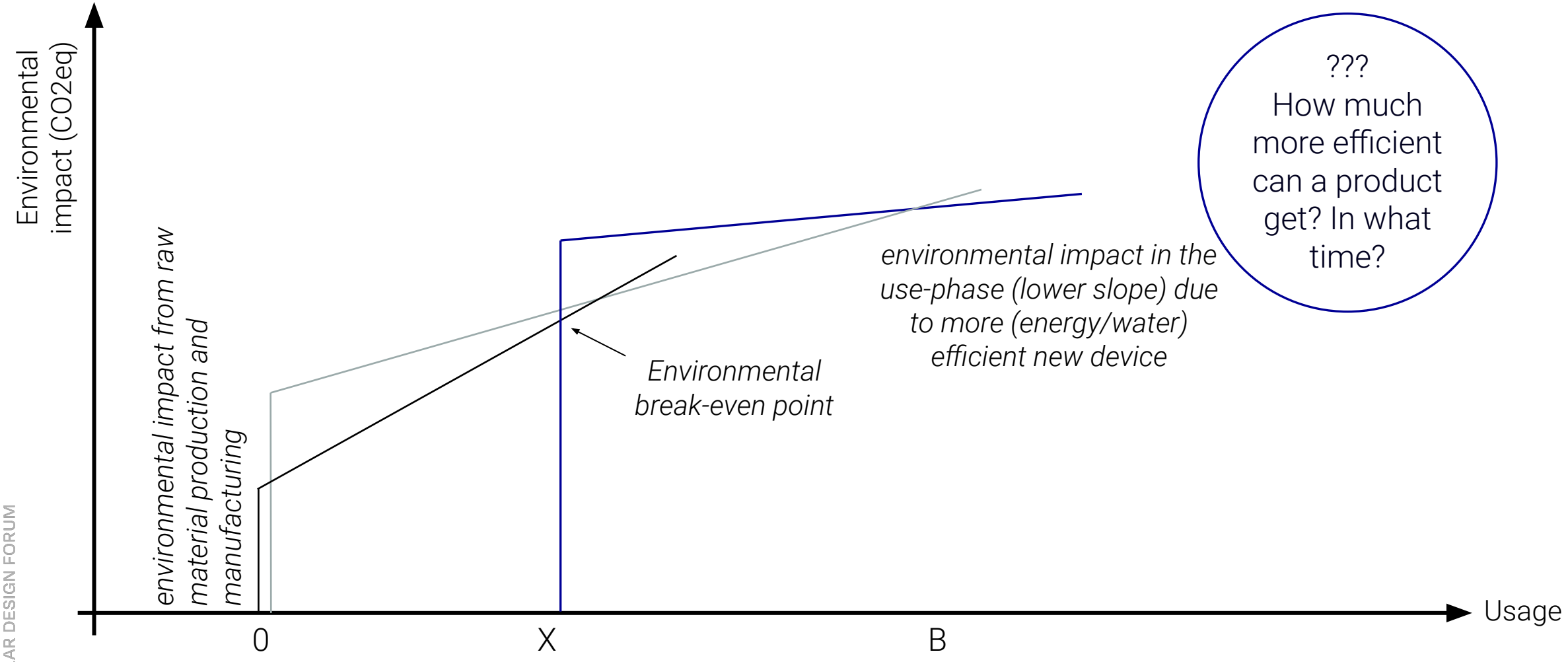
Source: Berwald et al. (2020) - Environmental evaluation of current and future design rules

The Ecological Price of Modularity



Proske et. Al. (2016) “Life Cycle Assessment of the Fairphone 2”

→ Impact of high material & low emission vs low material & higher emission – and technical advancement



→ Circularity strategies may cause

targeting conflicts

Reference	Focus
CLC/TR 45550:2020	Definitions
EN 45552:2020	**Durability (incl. reliability)**
EN 45553:2020	Remanufacture
EN 45554:2020	**Repair, reuse and upgrade**
EN 45555:2019	**Recyclability and recoverability**
EN 45556:2019	Reused components
EN 45557:2020	Recycled material content
EN 45558:2019	**Critical raw materials**
EN 45559:2019	Methods for providing information

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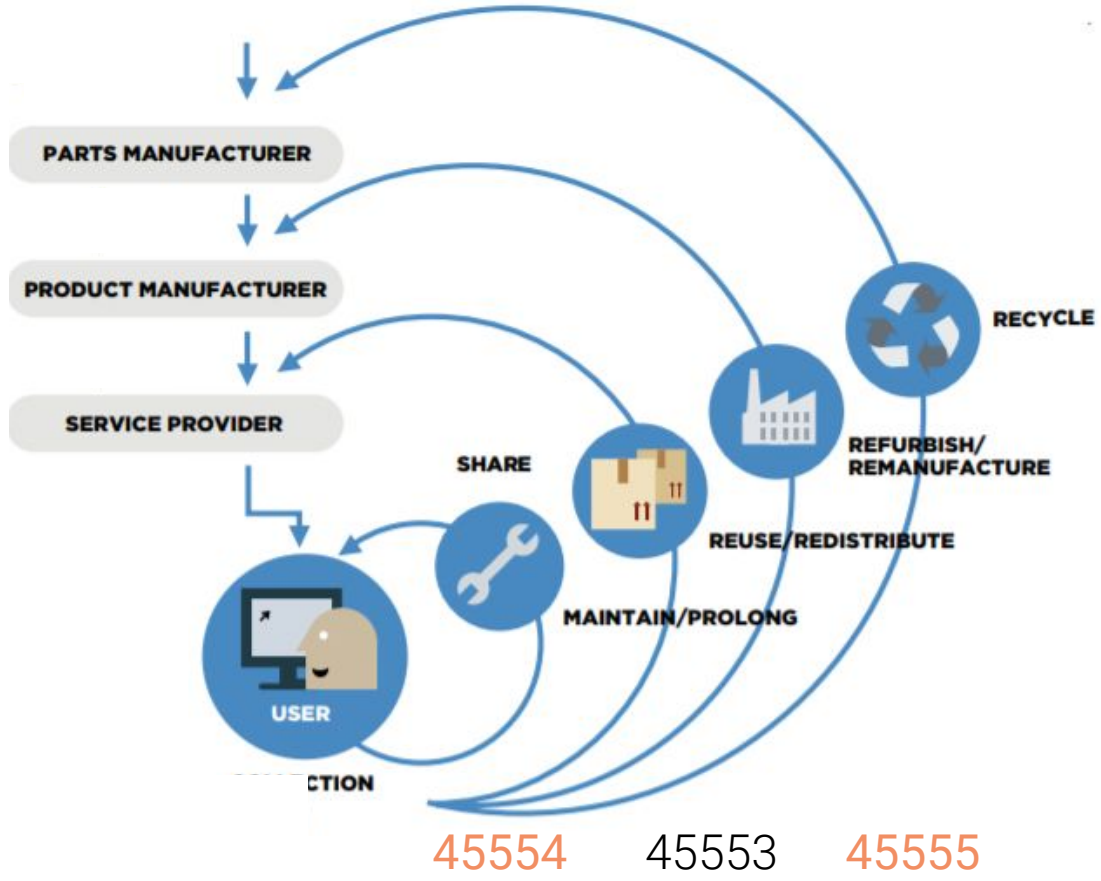


b2b Lighting

A question of interpretation

Unfortunately Data can't be shared

Global warming potential

Abiotic resource depletion potentials

With the current design(s)
REPAIR does not make sense:
- from an ecological pov (transport)
- from an economic pov (time & effort)

MedTech Component

A question of scope

Unfortunately Data can’t be shared

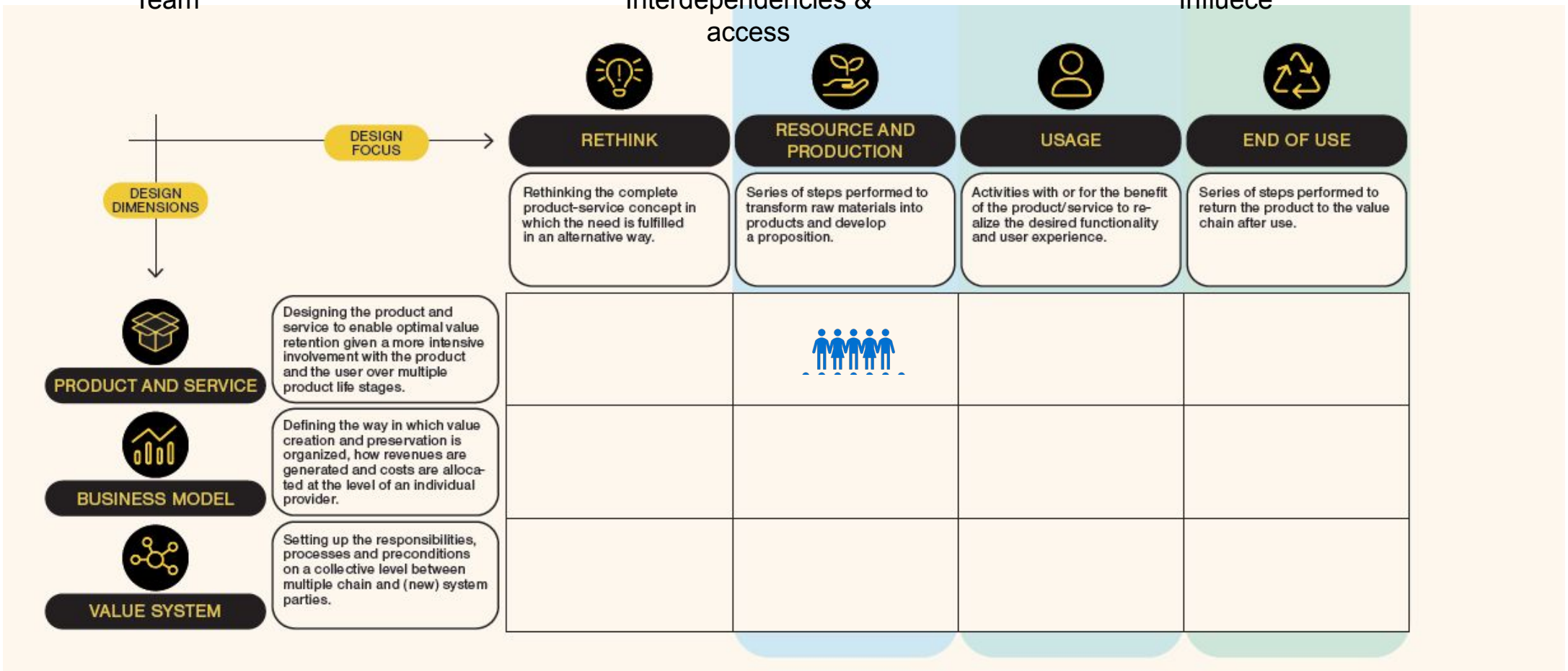
The task force could only improve designs within given dimensions, changing dimension for better exploitation of space is not an option

A question of scope & feasability

Team

Interdependencies & access

Influece



(Design) challenges in funiture

Business potential considerations for LCD

TNO Fingerprint method

How is value created?
How could it be preserved?

What 10 product properties play a role?

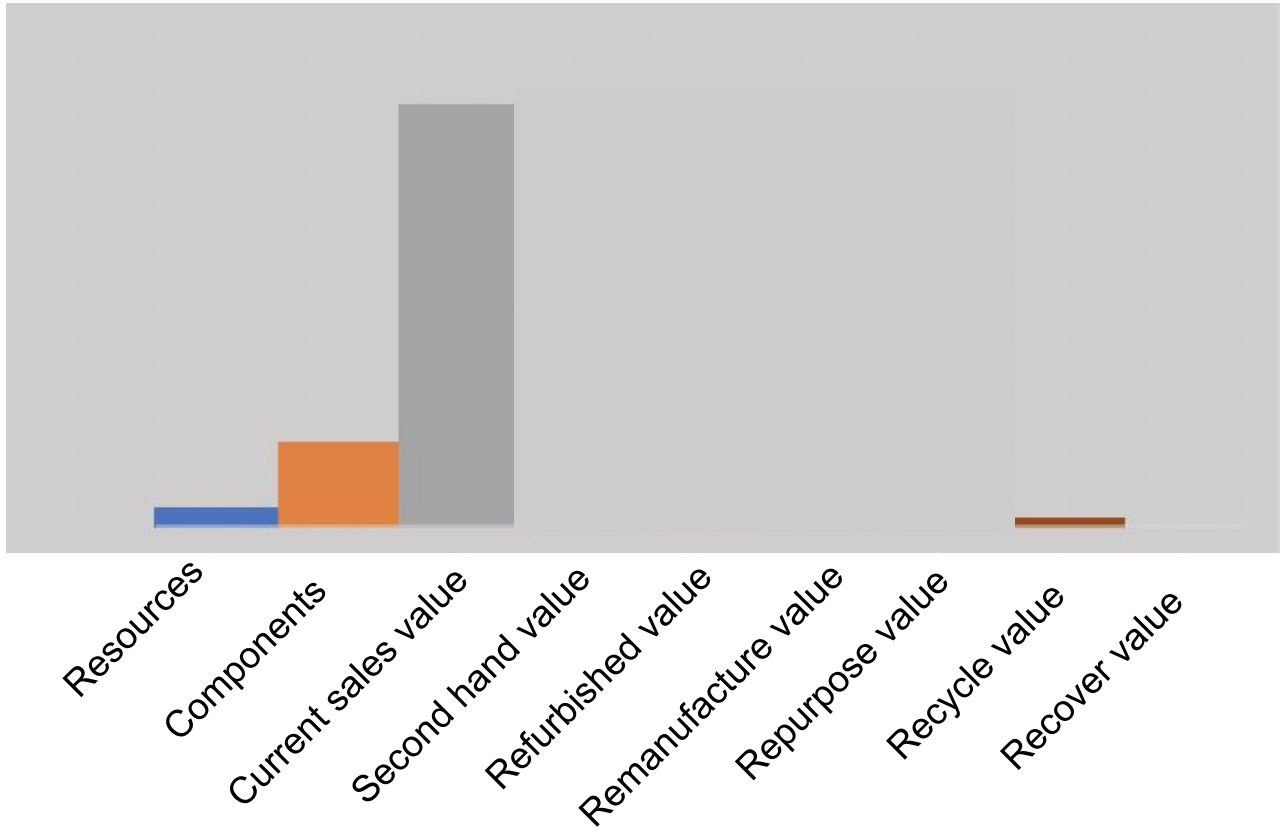
- Technical life
- Price per item
- Repairability
- Can the product use be planned
- Modularity
- Adaptivity
- Recyclability
- Frequency of use
- Labor intensity
- Sensitivity to fashion trends

Case of Landal | OT Design

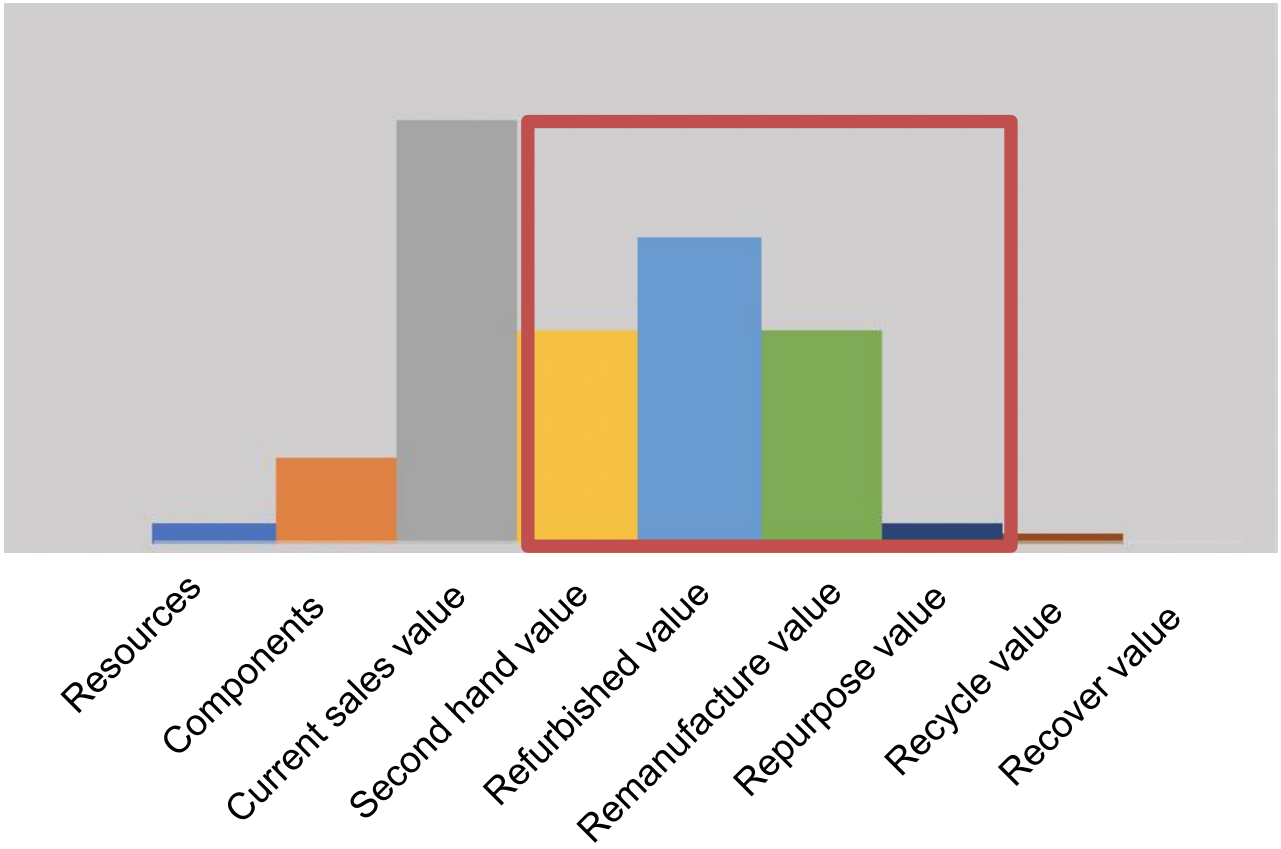
- Sourcing and material assessment done in-house
- Short cycle, after 7 years end-of-life, sometimes earlier (technical life)
- Furniture that is used intensively (frequency of use)
- Fully glued and stapled (reparability)
- Repair expensive (labor intensive)

Conclusion: value preservation is difficult

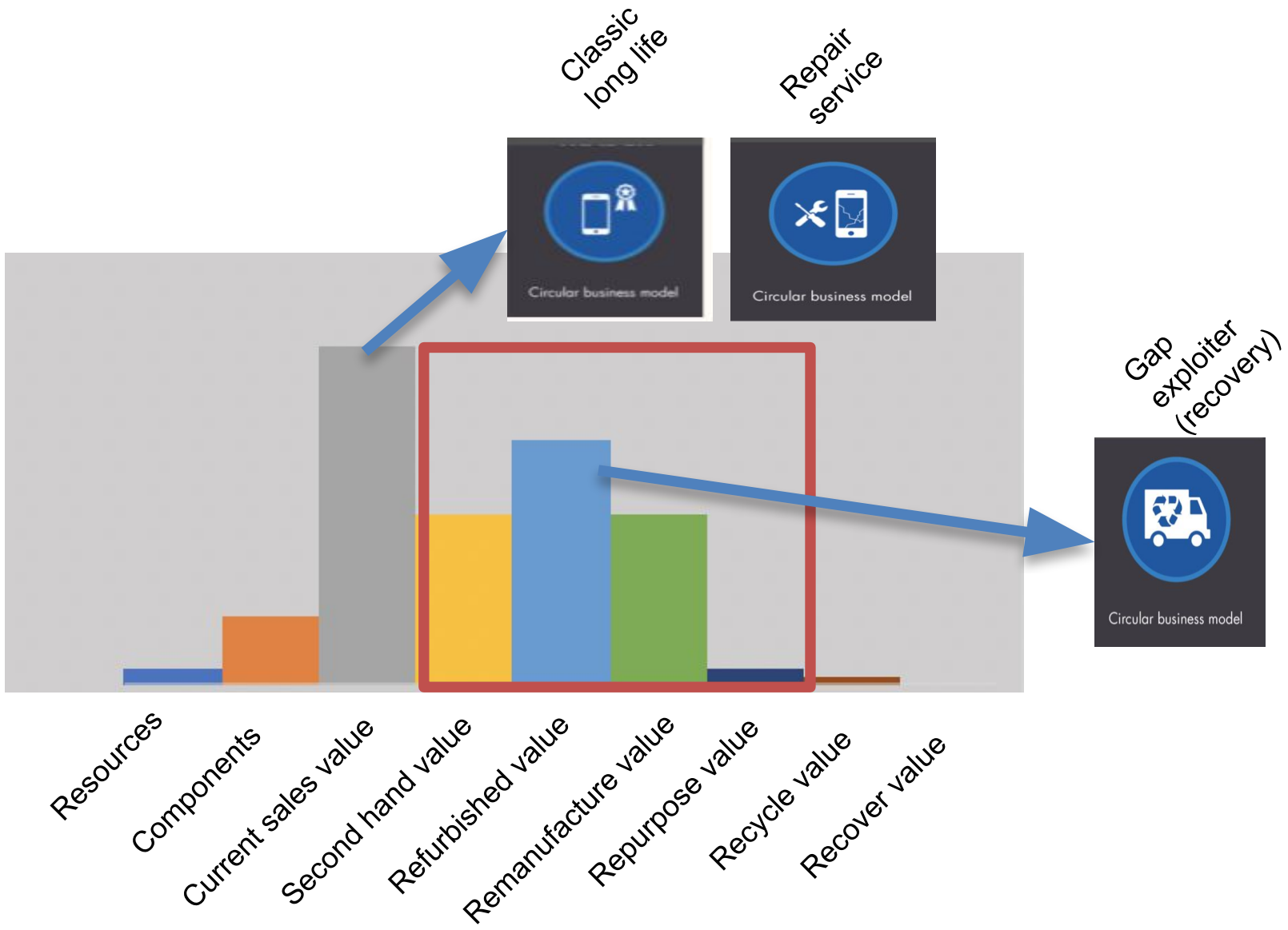
Business potential: value preservation



Business potential for multiple lifecycles



- **Technical life**
- Price per item
- **Repairability**
- Need to be planned
- **Modularity**
- Adaptivity
- **Recyclability**
- Frequency of use
- **Labor intensity**
- **Sensitivity to fashion trends**



Interaction, round 2

First topics for discussion

1. Business potential assessment

What would be the consequence when the business potential is also taken into consideration in project scoping

- → Are you already taking business potential into account?
- → Are the outcomes significantly different than without?
- → Dilemma; how to you rate;
  - An intervention with a high environmental impact but limited probability of implementation because of a low business potential versus
  - A lower environmental impact with a high probability of implementation because of a high business potential

Sector challenges

Sector specific product and service challenges

Design elements	Electronics challenge	Furniture challenge
Recycled or biobased material	Global plastic value chain	Local sourcing for wood
	PCB are standardised	Long chain for textiles
Efficient production	Yield driven industrial process	Local more flexible production
Environmental impact usage	Energy consumption	Cleaning hard to influence
Replacement triggers	New generation tech push	Need push from trends / fashion
	Defects	Defects
	Functioning within a system	Restyling of entire interior
First use extension options	No DIY repair, prof system needed	Limited DIY, Replacement of cover
	Software upgrades possible	Graceful aging / user attachment
	Technical obsolescence	
Product re-use	Limited demand, complex logistics	Broad variety of products
Product collection	Open loop system required	No specific system. Waste collection
	Systems differ per country	
End-of-use treatment	Shredding and material recover	No standard treatment, Incineration

Sector specific business model challenges

Design element	Electronics challenge	Furniture challenge
Cost saving	Focus in industry	Supplier specific
	Long optimized value chain	Mostly in circle of influence
Efficient production	Risk avoiding attitude	Flexible
Customer relation	Brand based	Product based
	Retail or other channel	Less massive channels
Adding paid service	Variety of markets	Closer to market
	Powerful content industry	Not used to services
Repair options	Incentive for prof system	Service option
	Spare parts	
'As a service' option	Aggregator needed	Possible but paradigm shift
Product re-use / component harvest	Complex volume game	
Material re-use	Closed loop needed	
	Not for individual supplier	

Sector specific value system challenges

Design element	Electronics challenge	Furniture challenge
Design for recycling	Country specific recycling process	No process in place yet
Use of recycled materials	Predictable quantities Consistent quality	Textiles on national level Wood from multiple sources
Repair	No DIY, infra for repair and spare parts	
End-of-use logistics	Open loop system Challenge for sorting Not designed for disassembly	Closed loop possible Size a limiting factor

Interaction, round 2

second topic for discussion

2. Sector characteristics

Based on provisional sketch of challenges for the two sectors;

- → First feedback on the design challenges as formulated per sector / your sector
- → On what level (sector, product category, product, component) should or could this input be defined?
- → Is this sector input relevant and of added value for life cycle considerations?
  - E.g. how to deal with broad range of challenges on value system level?
- → Are there consequences of this differentiation regarding design process, -capabilities and -inputs

What more is to be discussed

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