The ‘Big Five’ Structural Wastes

An Introduction

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Redefining Waste | Circularity Thinking

We consider linear economic systems intrinsically wasteful, but what ‘waste’ and ‘wasteful’ mean are important to unpack. We often think of waste as ‘something we throw away’ or ‘something to dispose of’. But isn’t it a waste that we don’t use something for longer, or don’t use to its full capacity? Isn’t it a waste that we have produced something in the first place, if we could have delivered the same value without a physical product to an end-user?

Waste can then be seen as something beyond its conventional definition – so often less obvious or visible, and inherently built into a system. These are known as **structural wastes**.

Structural waste inherently limits our ability to become more resource efficient, reduce our environmental impact and progress towards a **circular economy**.

Viewing waste as layered, multifaceted and not always visible is integral to the philosophy of **Circularity Thinking.** This is a key underpinning principle of Big Five Structural Wastes tool and its effective use.

Overall, while the Compass is helpful in identifying flows, and in exploring what possible solution spaces are available, however, as some types of waste are easier to identify than others, it is helpful to be able to examine situations where waste may be present in a more structured manner. This is what the ‘Big Five’ Structural Wastes helps in doing: finding waste, wherever it may be present.

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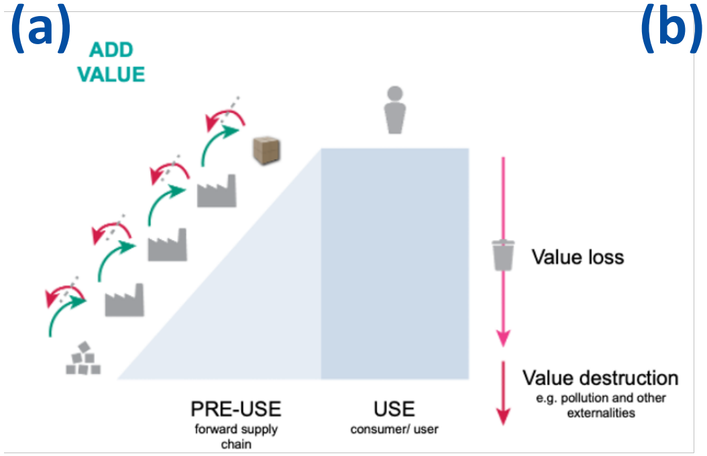
Big Five Structural Wastes | Purpose

Knowing the resource flow is the basis for discovering structural waste and developing circular strategies to tackle this.

Transitioning from **linear (a)** to **circular (b)** economy requires:

- Mapping the flows of resources in a system (e.g, an organisation's value chain).
- Understanding the flows of materials from their base state, at element or particle level, all the way through to product level, its use and end of life.

(a)



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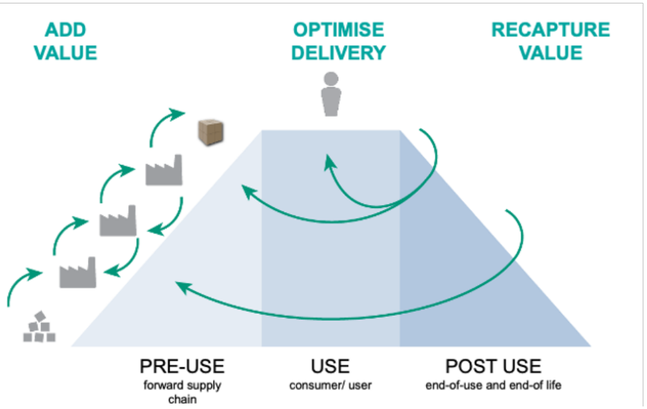

The Big Five Structural Wastes is a tool that allows:

- The user to interrogate a system to identify the **five types of structural waste along the value chain and product life cycle.**
- Specific strategies for managing each of the wastes identified. Each maximizes value extraction of a resource, helping transition to circular systems.
- **Circularity Thinking** to be employed: by taking a systematic view, following resources from cradle-to-grave and focusing on mitigating waste by **recapturing value from a resource**.

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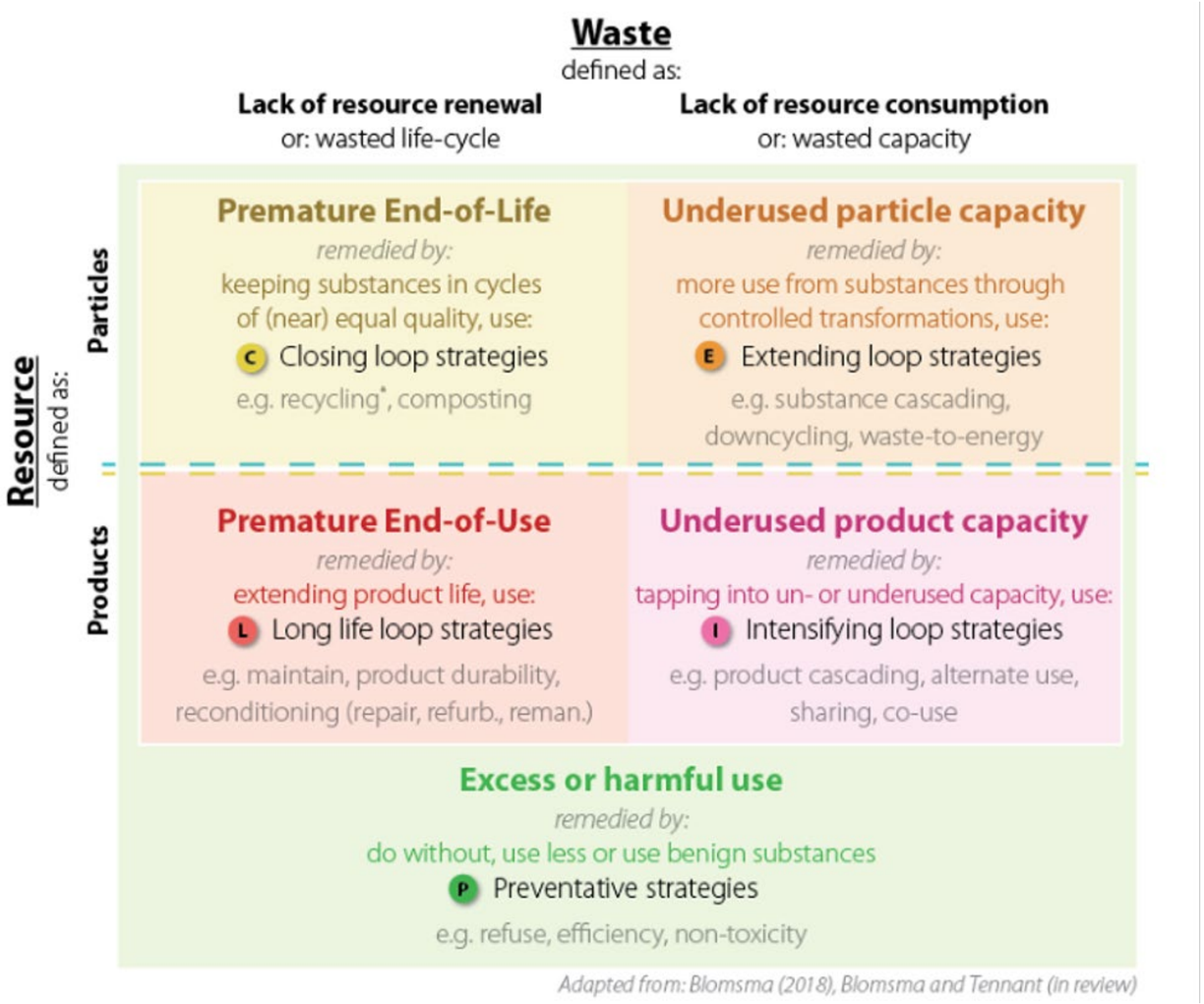
Big Five Structural Wastes | Structure

The structure allows one to search methodically along the value chain and manufacturing cycle, where and what kind of waste is hidden.

Note: this concept is **NOT** about being academically and factually correct all of the time. In reality, the correct allocation of a waste could be debatable – depending on the point of view. However, it is a good mental structure and conversation fuel.

Ultimately, our goal is to create the most circular and resource efficient systems possible, mitigating linearity and driving circularity.

For this purpose, the Big Five Structural Wastes is based on a typology that considers two main types of resources where waste primarily occurs, particles (e.g. elements, substances, materials) and products (e.g. finished goods), and two main types of waste: a lack of resource renewal and a lack of resource consumption



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Big Five Structural Wastes | Structure

The tool sits on two axis:

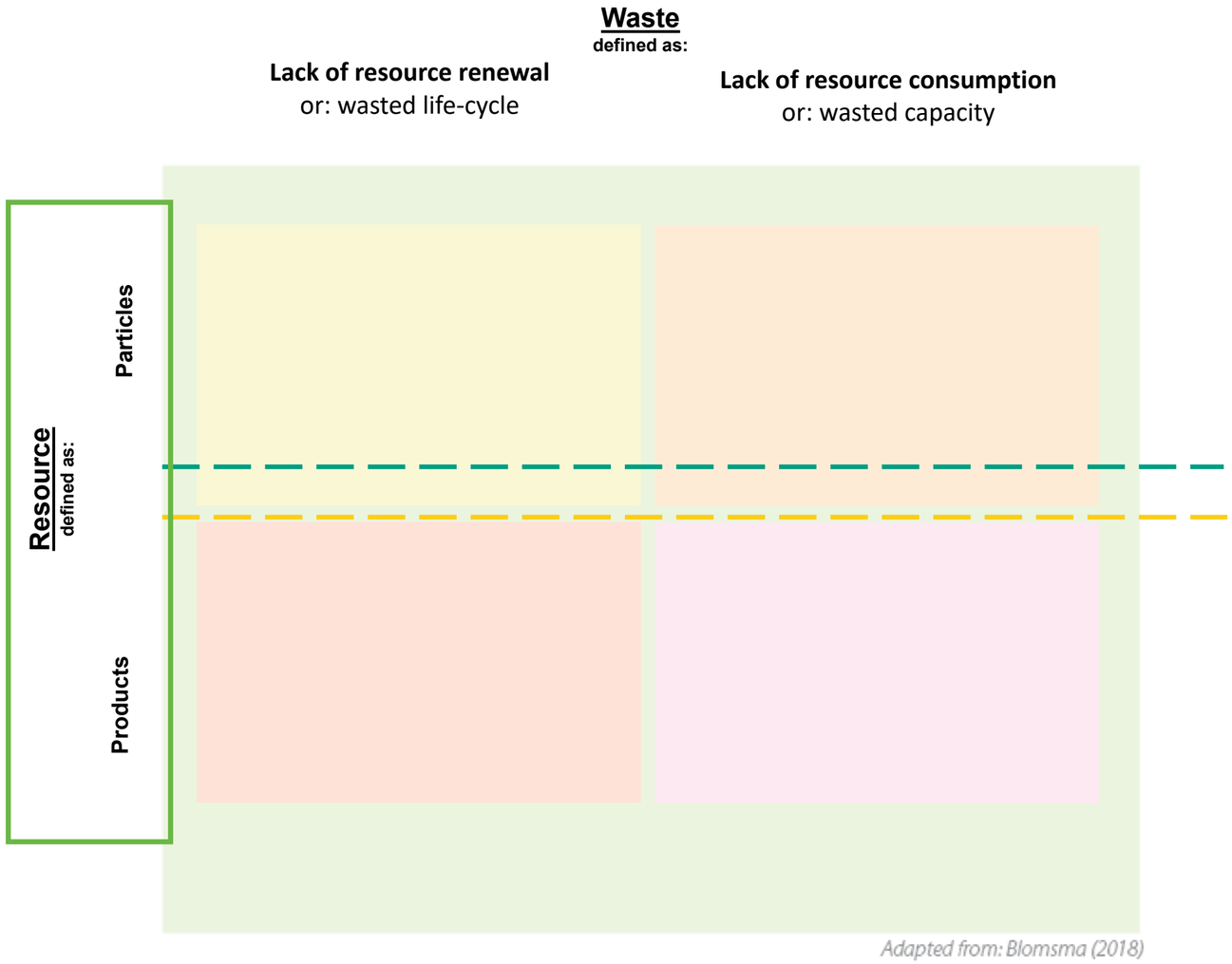
- ***Waste***
- ***Resource***

It splits *Resource* down into two categories:

- **Products** – *finished products* or their *components*
- **Particles** – this refers to anything at sub-product/component level - *elements, compounds or larger materials*.

Example: Jeans

- **Products** – the jeans themselves
- **Parts and Particles** – materials such as the denim and leather; the organic virgin cotton which enters its making and particles like in chemicals or paints



Adapted from: Blomsma (2018)

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Big Five Structural Wastes | Structure

The tool sits on two axis:

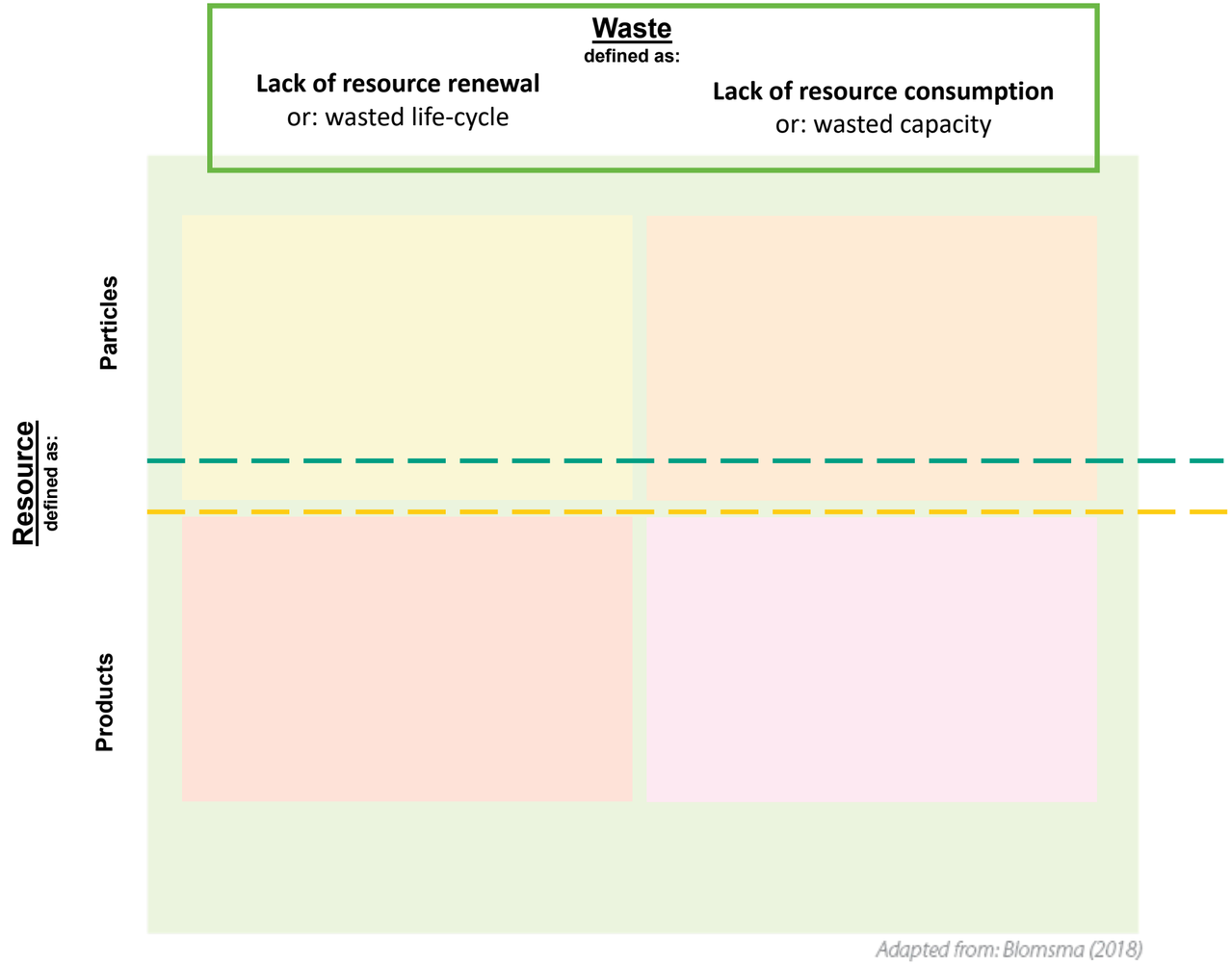
- Waste
- Resource

It also groups waste under 2+1 types under which value is lost unnecessarily:

- **Lack of resource renewal** (Wasted Life-Cycle) – resources are not returned to states meeting pre-defined standards
- **Lack of resource consumption** (Wasted Capacity) – the maximum potential of a given resources is not exhausted or used up.

and at the base of it all:

- **Excess or harmful use**- a given resource is being (over)used inefficiently or is generally harmful to use, all across the value chain, but mostly during production.



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Big Five Structural Wastes | Structure

Based on this typology, the tool defines ***five*** *types of structural wastes,* which fall under *Particle* or *Product* classifications:

In the first row, at a *Particle* level, we have:

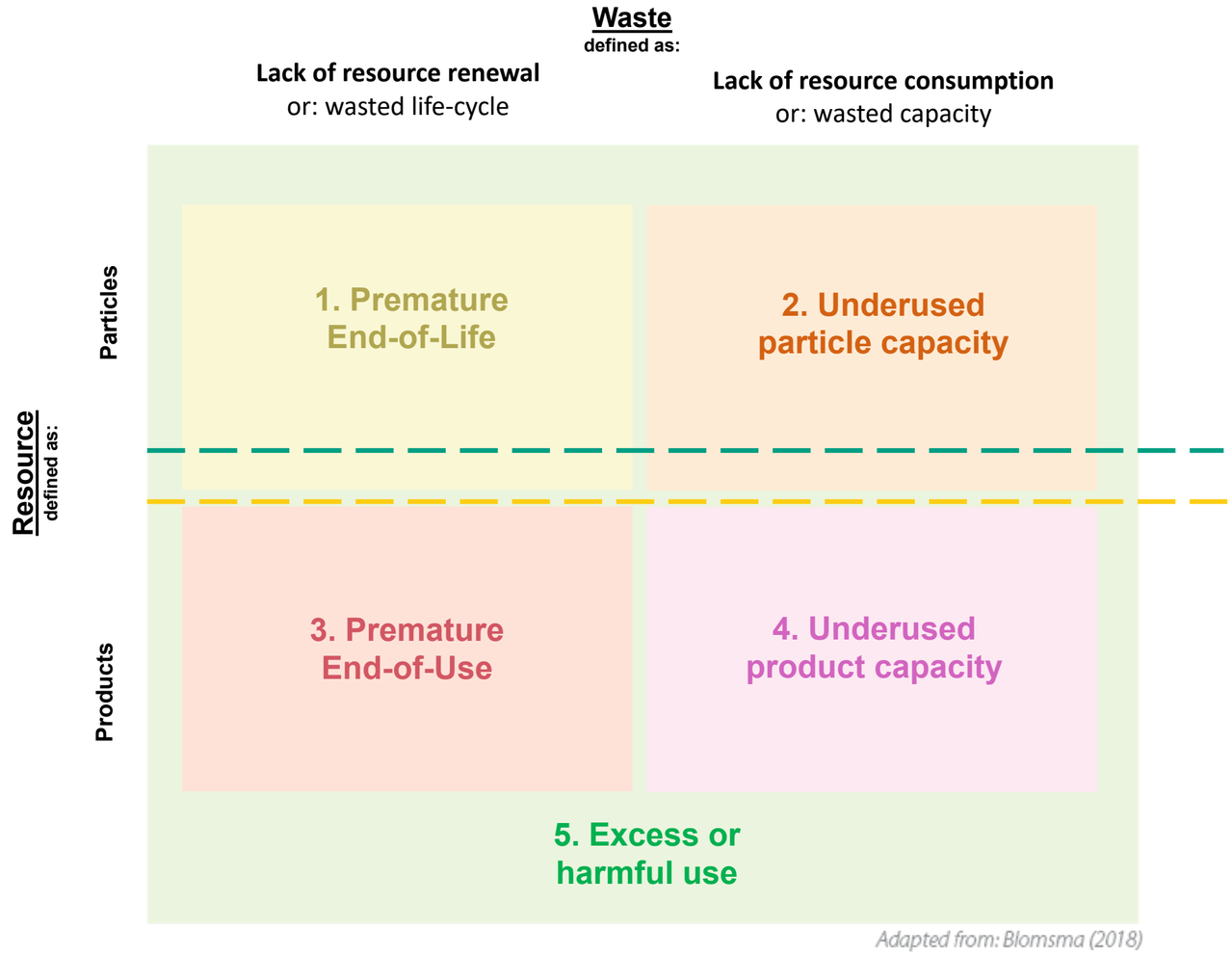
1. **Premature End-of-Life**
2. **Underused Particle Capacity**

In the second row, for *Product* level*:*

3. **Premature End-of-Use**
4. **Underused Product Capacity**

And across both Particles and Products, sitting at the base:

5. **Excess or Harmful Use** *(where you may find significant hidden wastes!)*



Adapted from: Blomsma (2018)

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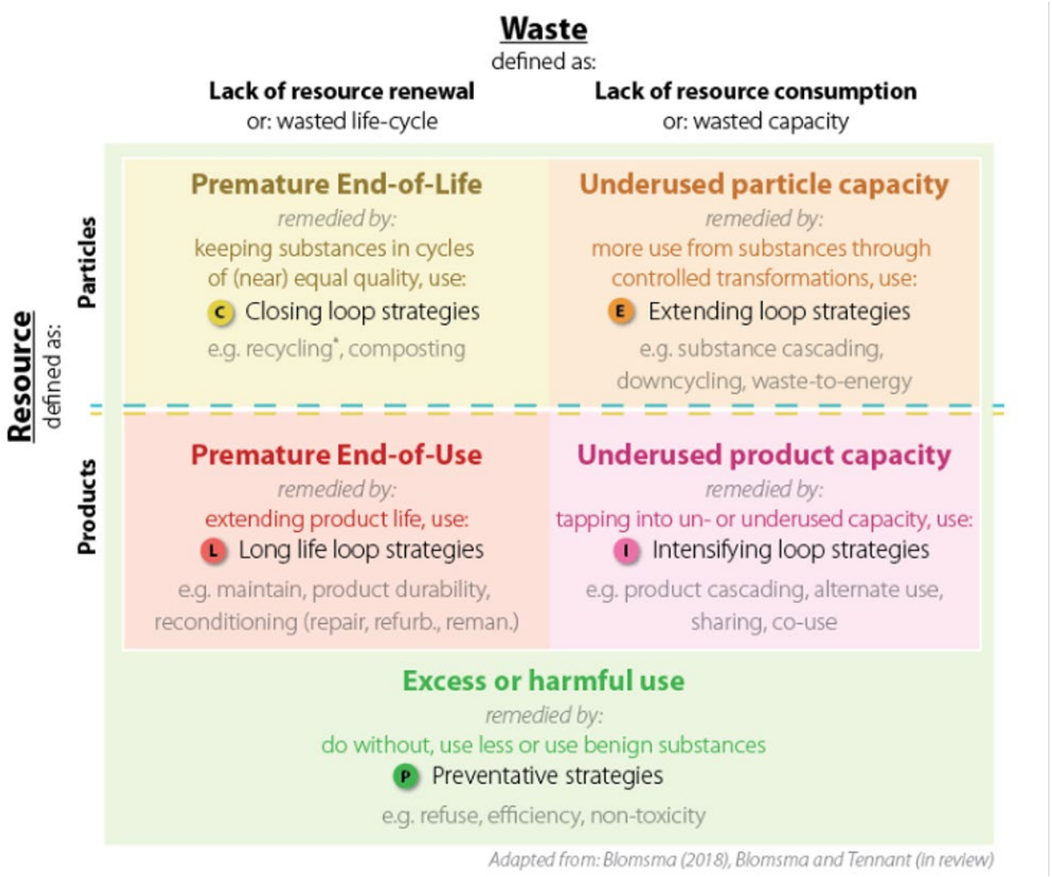
Big Five Structural Wastes | Structure

For each type of waste identified it recommends a *potential** *circular strategy* to mitigate waste and drive circularity:

1. Closing loop strategies
2. Extending loop strategies
3. Long life loop strategies
4. Intensifying loop strategies
5. Preventative Strategies

*Emphasis lies on ‘potential’ – not all strategies are equally appropriate or supportive or easy to combine



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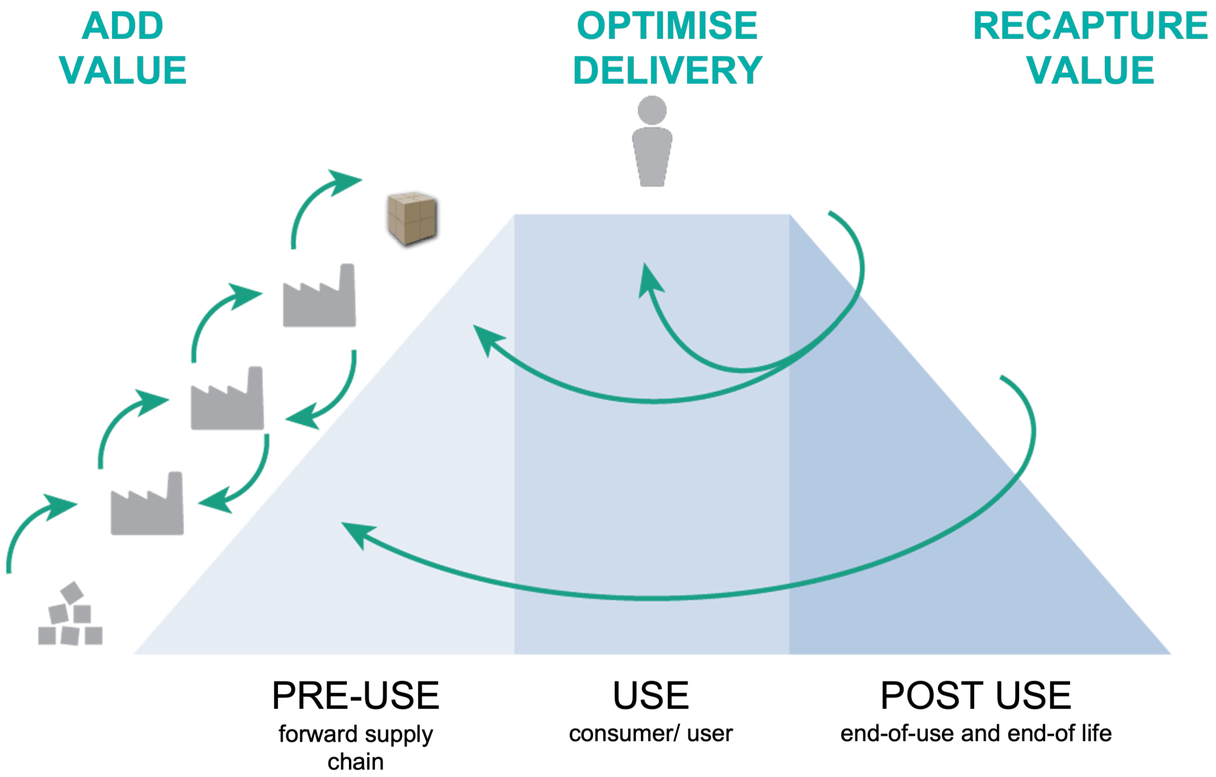
The Value Hill

The **Value Hill** can be used in this context as a means of illustrating the concepts contained within the Big Five Structural Wastes.

It can also be used as a tool to help businesses understand their position, find the lost value on the value chain and help develop circularity strategies.



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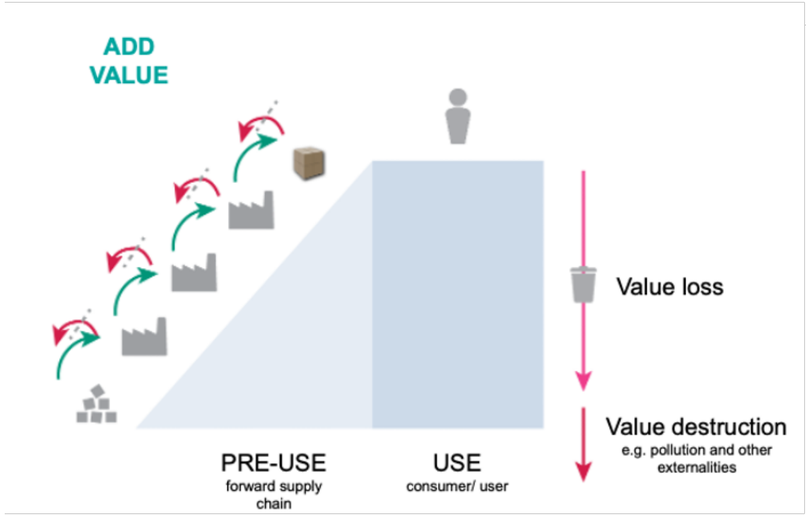
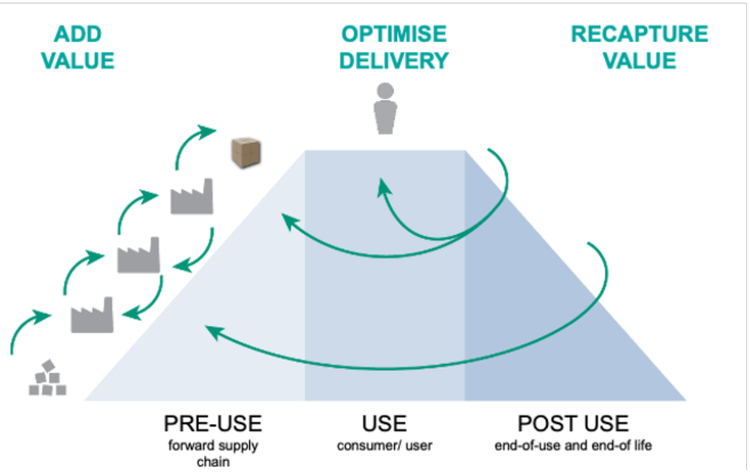
The Value Hill

The Value Hill picks up on the idea that one needs to determine what circular strategies are the most appropriate in a particular context. It points out the nature of manufacturing: take resources, and through various stages of manufacturing, generate a product that is used for a while – however, at the end of life, that value is lost, and we fall down a 'value cliff'. Additionally, if the products and materials end up in the environment, they contribute to value destruction, as they create pollution. If replacement products need to be created, then the cycle is repeated, including the emissions that are produced in the manufacturing stage.

Ideally, we should control how this process happens, identify the hotspots and retain value as long as possible. This is where the Value Hill and the Big Five concepts meet.

For more information on the Value Hill, have a look at the Introductory slides, and in additional resources.





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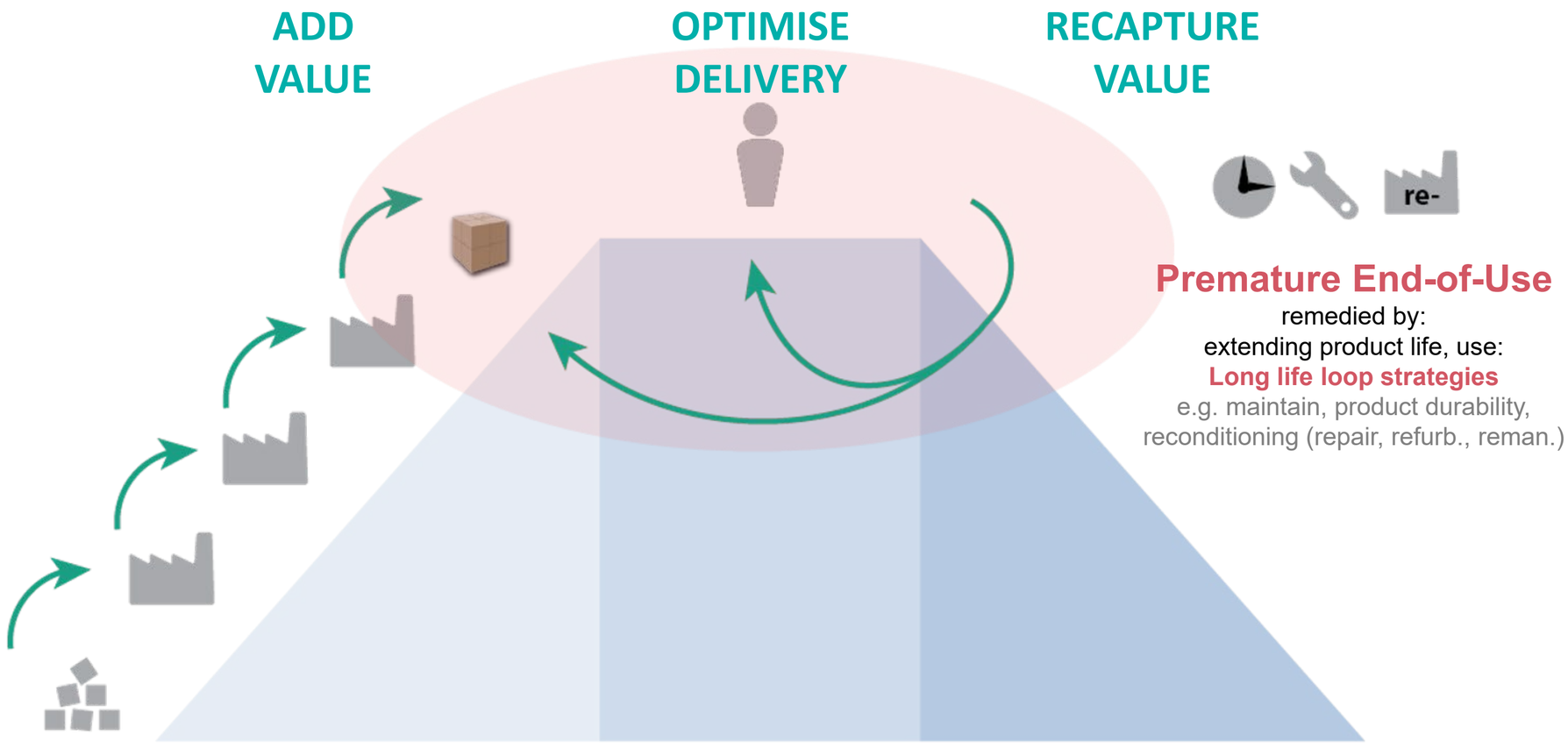
Big Five Structural Wastes: Premature End-of-Use



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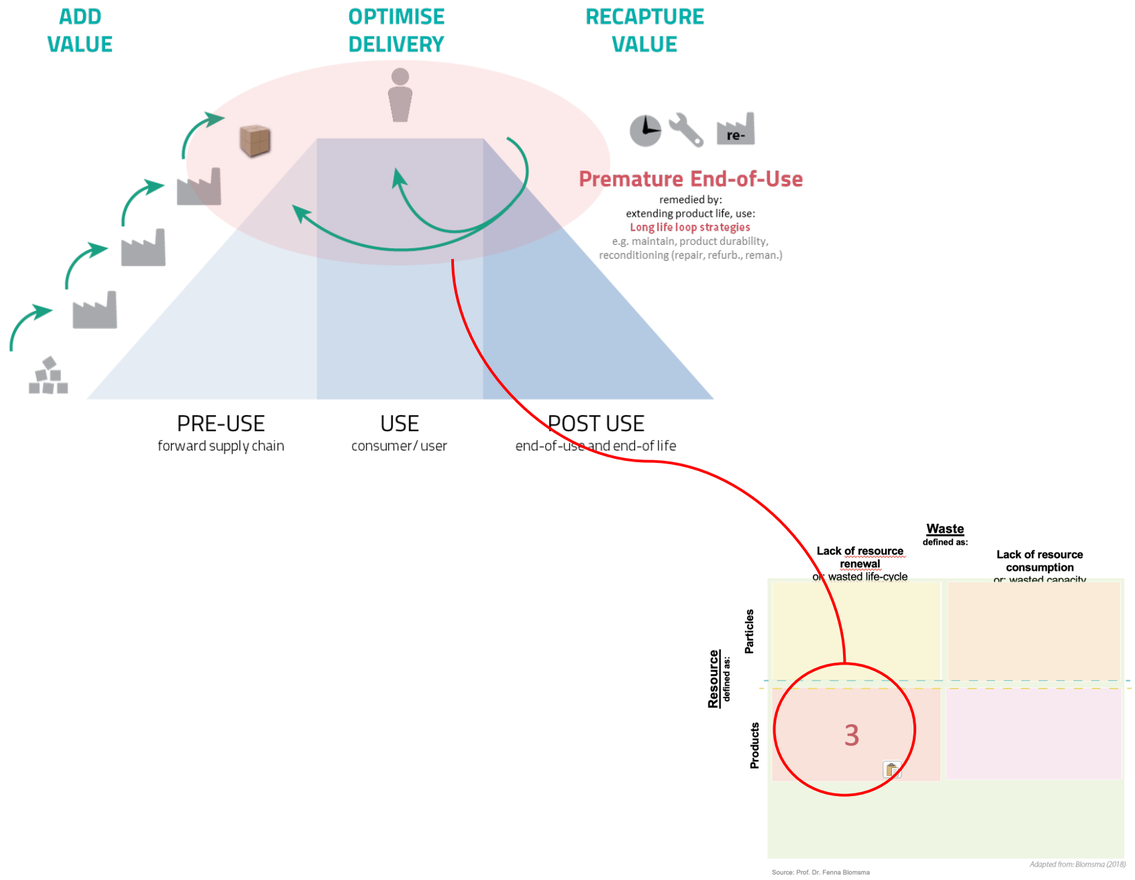
Big Five Structural Wastes: Premature End-of-Use



Examples:

- Hole in one end of the carpet, so the whole carpet is thrown away.
- Jeans are not from the current collection / not ‘stylish’ anymore, so are no longer worn.
- iPhone is fully functional, but not able to connect to ‘modern’ Bluetooth devices or to 5G, so it is not used anymore.
- Restaurants throw out dish washers and buying new ones.
- Empty bottles (e.g. of cleaning agent which is finished) are thrown away.

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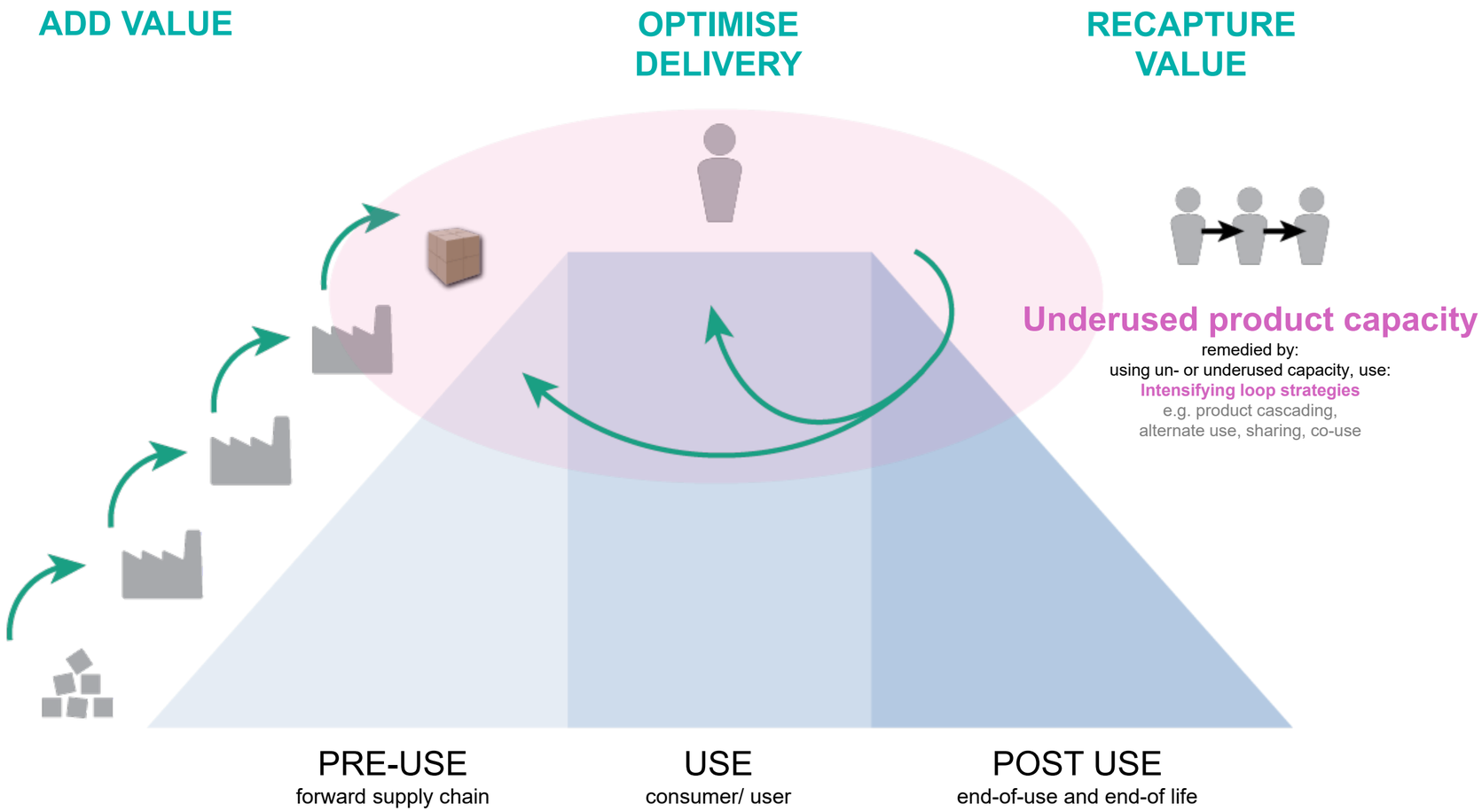
Big Five Structural Wastes: Underused product capacity



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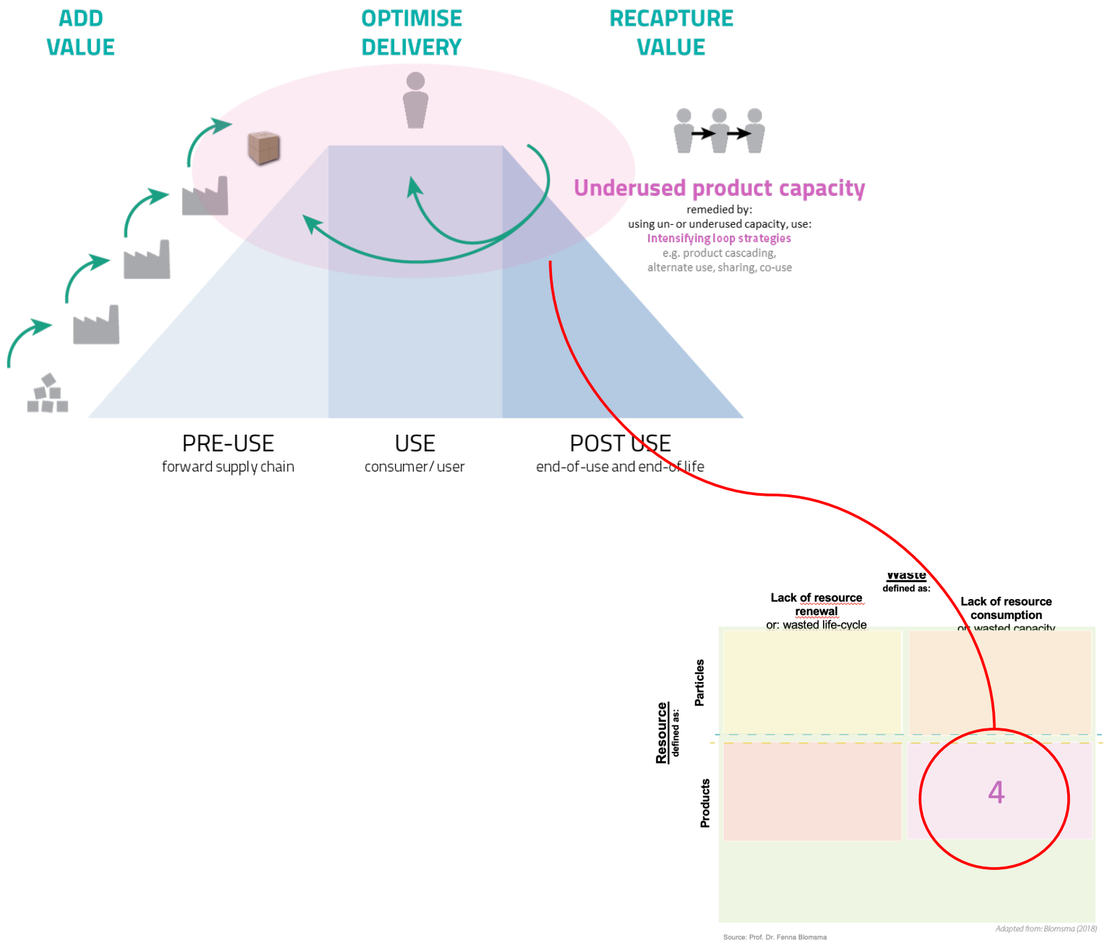
Big Five Structural Wastes: Underused product capacity



Examples:

- Jeans are worn just once in a while and not every day even if they can be, in theory.
- Carpets in offices are used only during daytime/when the offices are used. Offices are empty during COVID.
- A car is used about 5-10% of the time (other time is parking, searching for a parking space, sitting in traffic, ...). Also, car transports 1.5 people in average when it can fit 4+.

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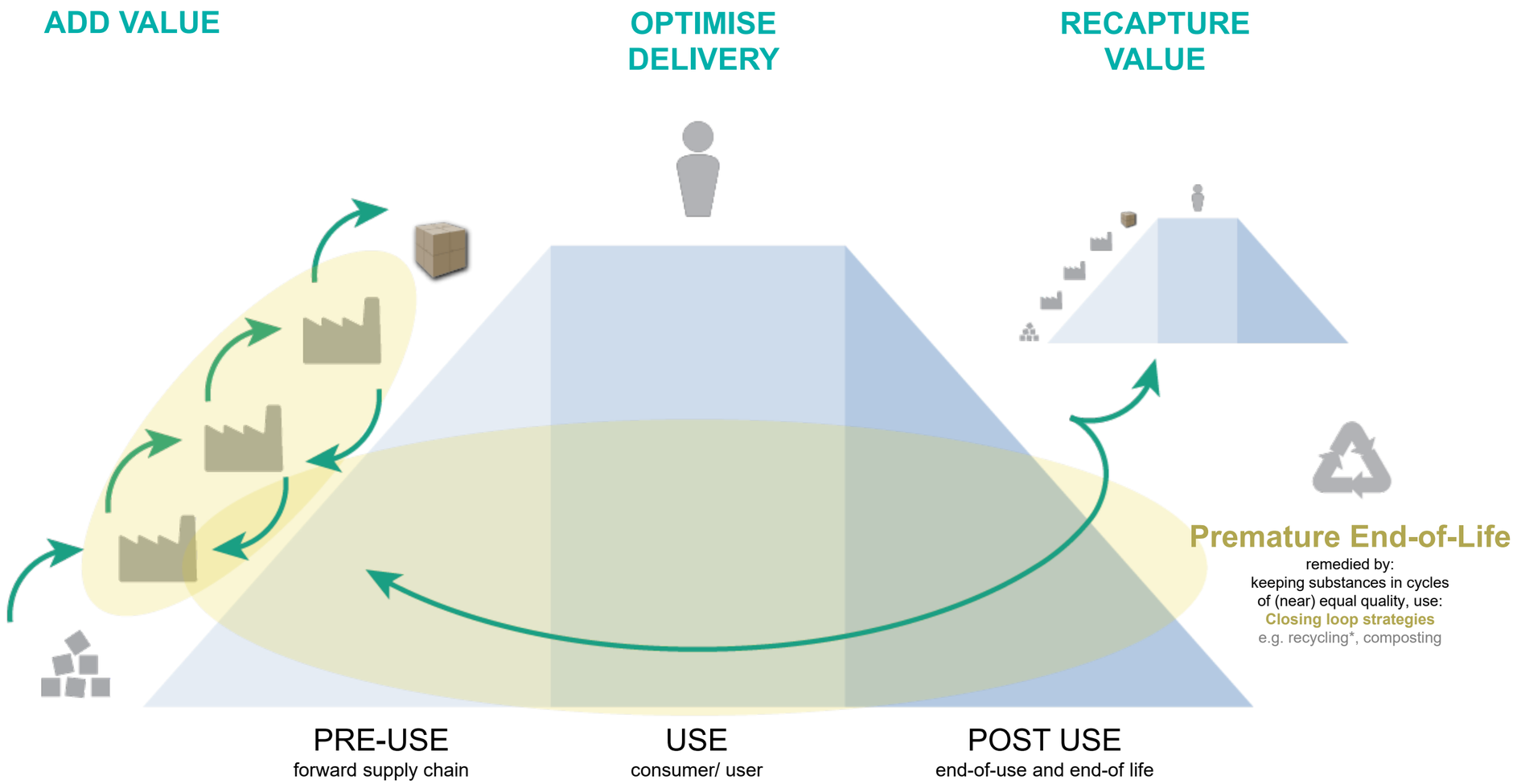
Big Five Structural Wastes: Premature End-of-Life



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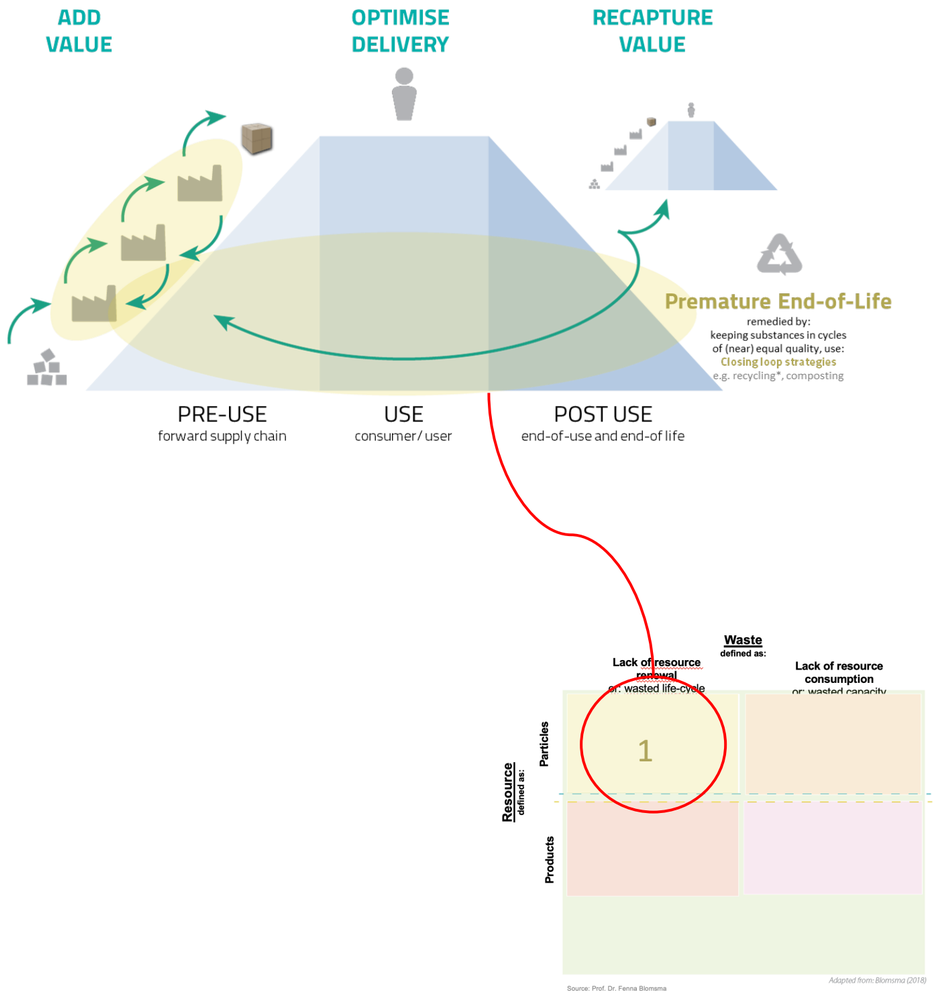
Big Five Structural Wastes: Premature End-of-Life



Examples:

- Fibres (from textiles) are burned even when they can be used still for making other textiles.
- Recyclable plastic is burned due to the design of specific nation-wide waste collection systems.
- Metals in electronics are destroyed during the ‘recycling’ process tailored to other materials in electronics (e.g. different melting points).

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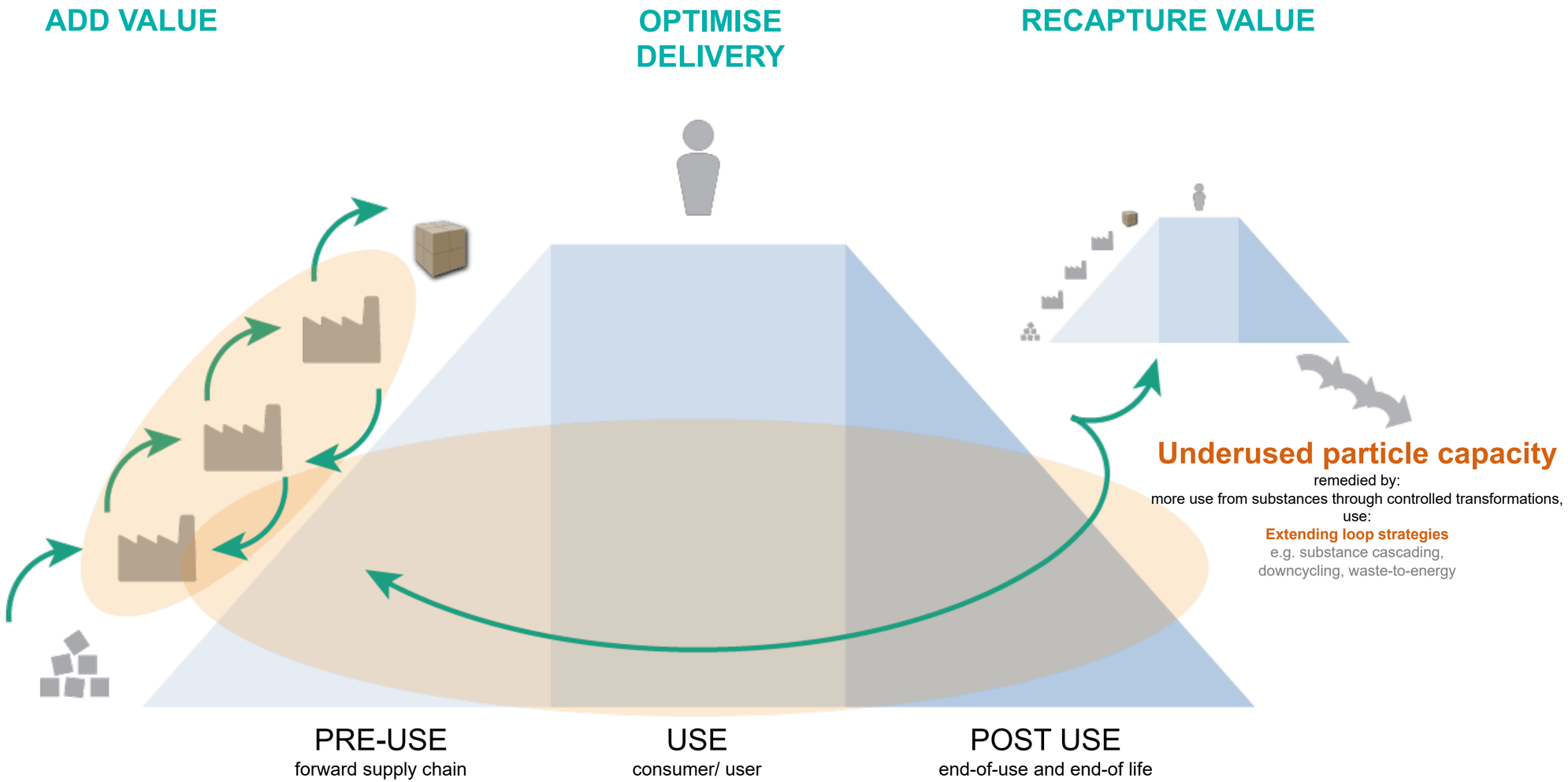
Big Five Structural Wastes: Underused particle capacity



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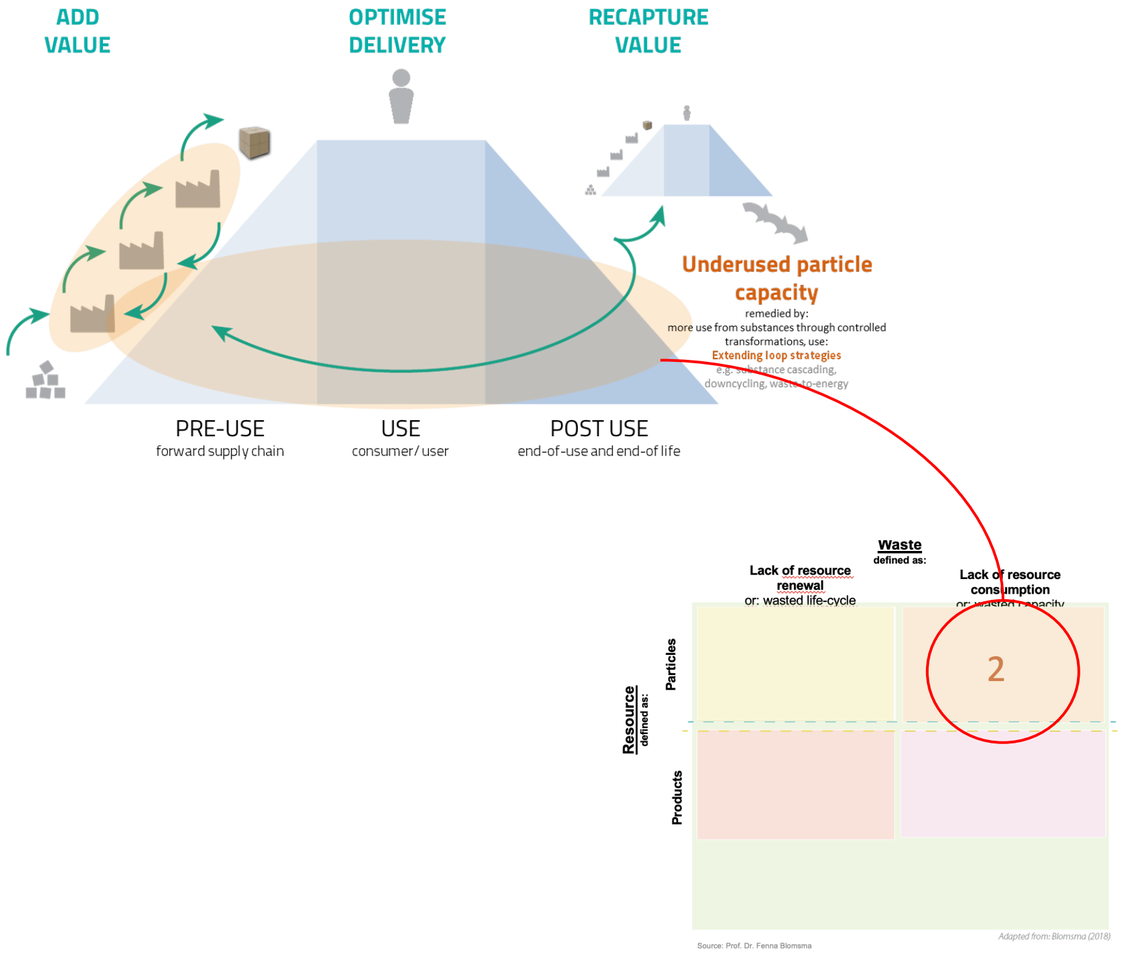
Big Five Structural Wastes: Underused particle capacity



Examples:

- Multiple by- and co-products from sugar production with potential uses are not used.
- Textiles (e.g. from carpets) are downcycled instead of re-cycled.
- Fishing residues are disposed of instead of biochemically exploited (e.g. protein for feeding animals or humans or pharmaceuticals).
- Wood-products are burned instead of exploited.
- Process water is cooled down to be allowed to be fed back into the river instead of used for heat-to-electricity production first.

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Big Five Structural Wastes: Excess or harmful use

ADD VALUE

OPTIMISE DELIVERY

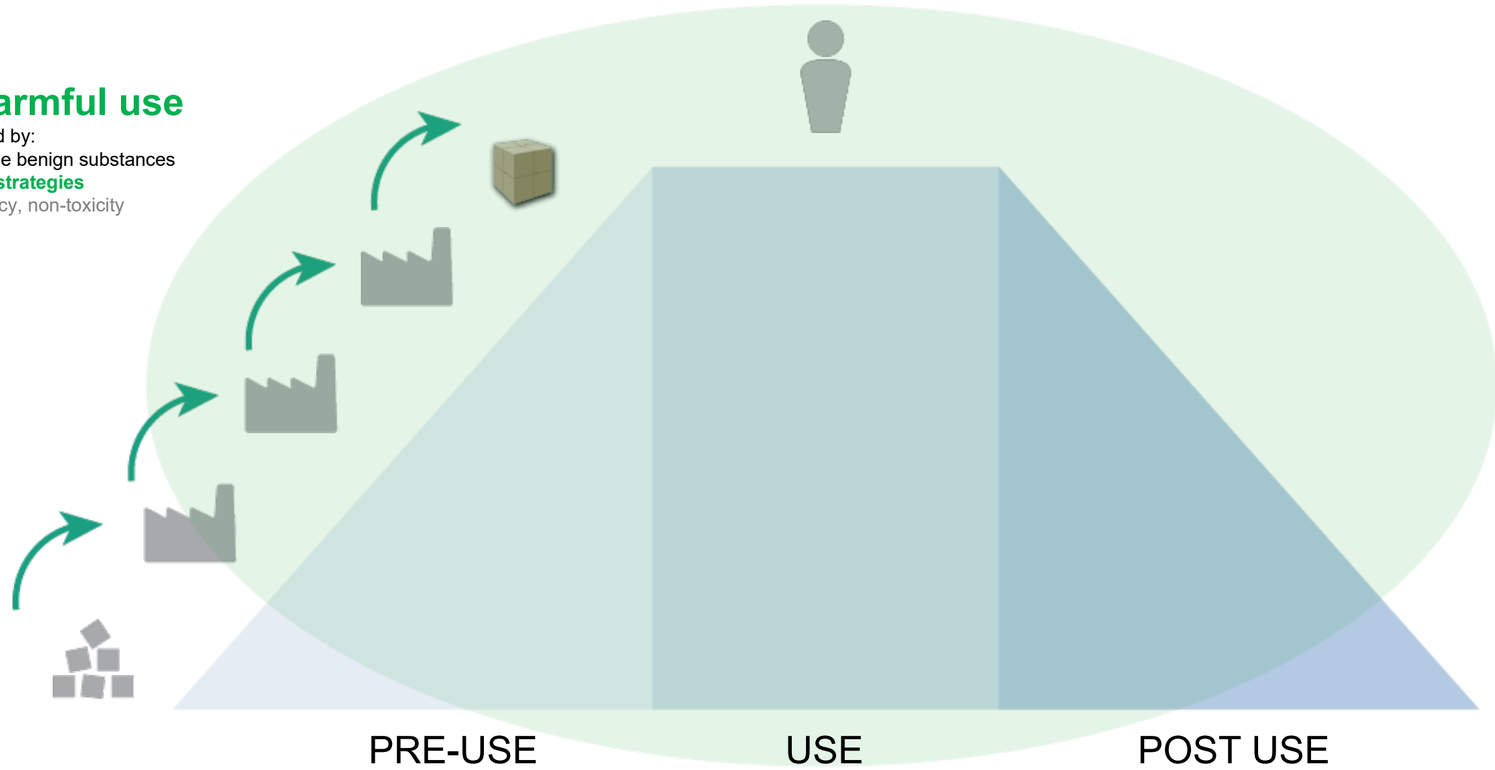
RECAPTURE VALUE

Excess or harmful use

remedied by:
do without, use less or use benign substances

Preventative strategies

e.g. refuse, efficiency, non-toxicity



PRE-USE
forward supply chain

USE
consumer/ user

POST USE
end-of-use and end-of life

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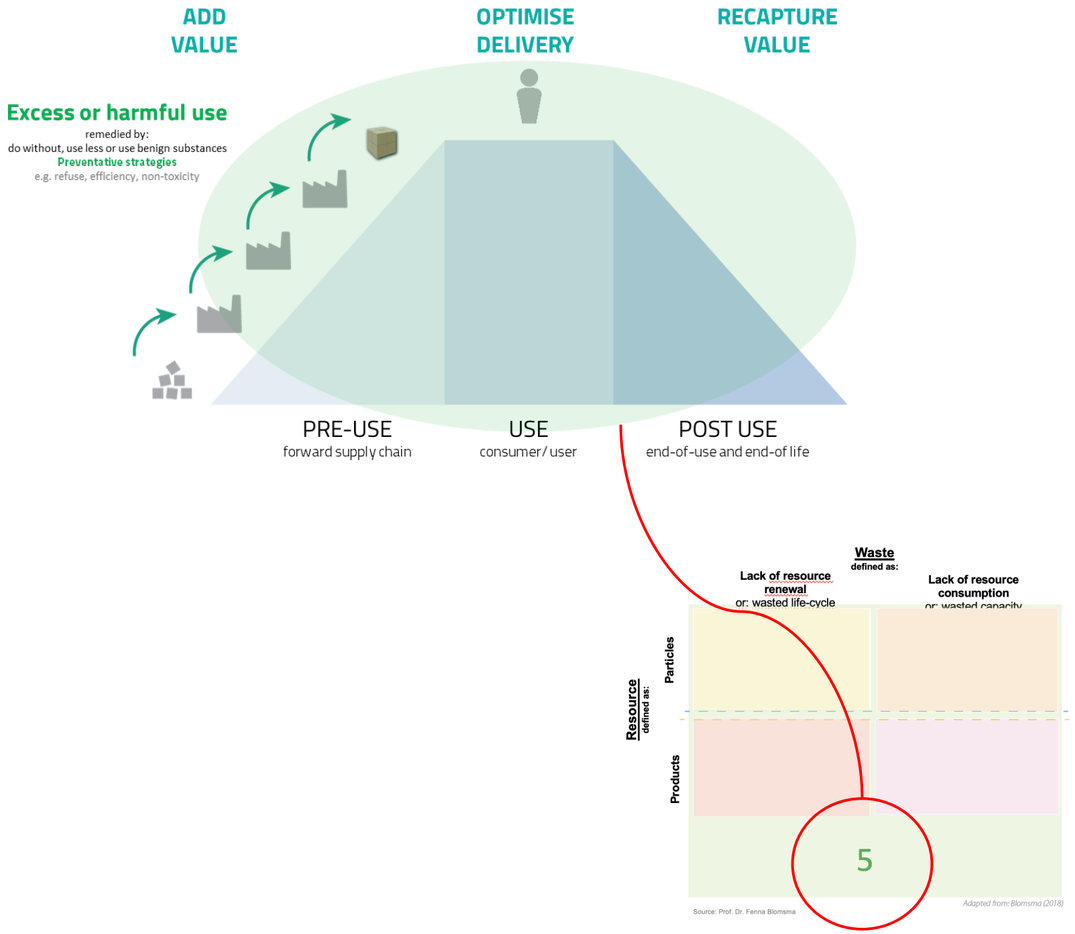
Big Five Structural Wastes: Excess or harmful use



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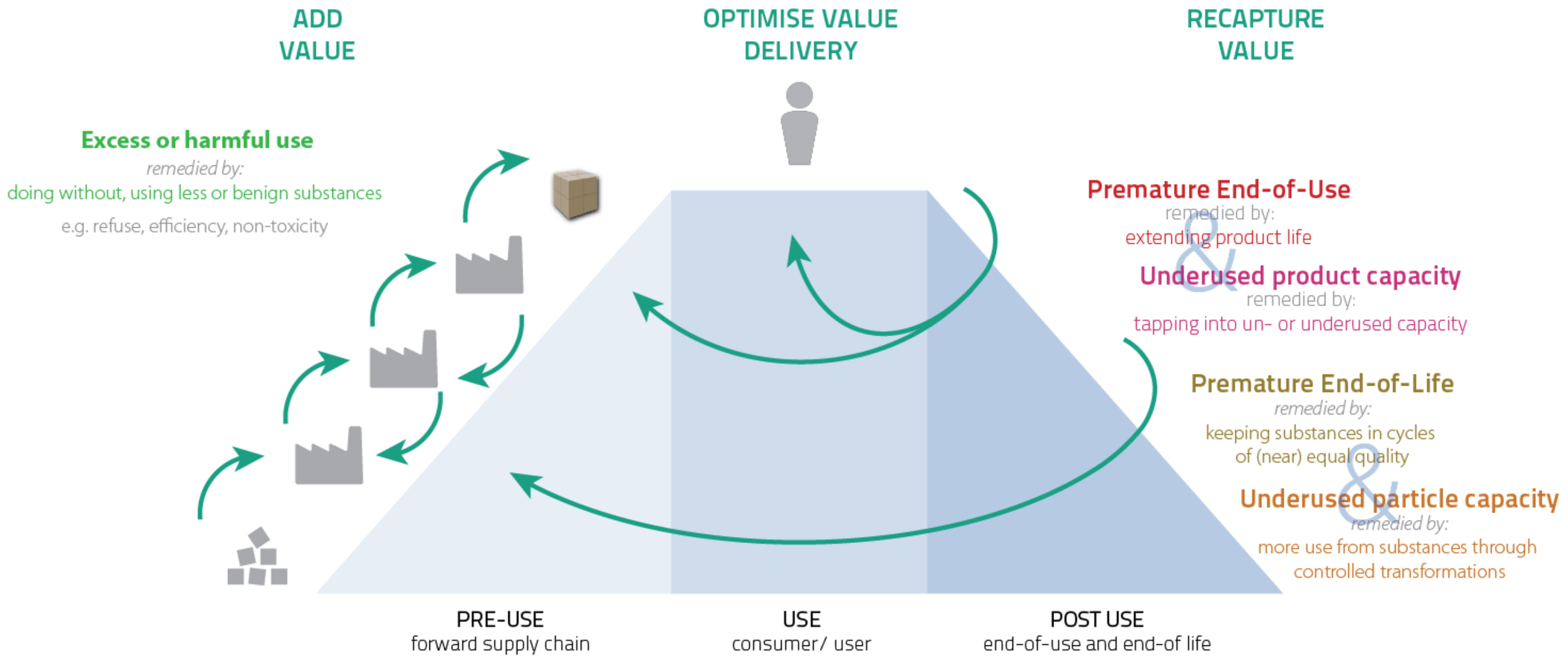
Big Five: Excess or harmful use



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Big Five Structural Wastes | Structure

Big Five #	Type of strategy	Main aim of strategies' type	Examples
1. Premature End-of-Life	Closing loop strategies	Contain or restore the quality levels of materials (close to) the original level.	Recycling (for non-biological materials), composting (for biological ones).
2. Underused particle capacity	Extending loop strategies	Extract more value from materials through controlled transformations. Materials are not returned to an early quality state.	Substance cascading, downcycling, waste-to-energy schemes, classic industrial symbiosis strategies.
3. Premature End-of-Use	Long life loop strategies	Extract the maximum value possible from a particular product. Strategies in this category serve to keep a product performing on consistent quality levels.	Maintenance, repair, refurbishment and upgrading, durability approaches (e.g. low-wear materials).
4. Underused product capacity	Intensifying loop strategies	Tap into the unused or under-used capacity of a product, including facilitate the subsequent use of a product for its intended or an alternate purpose.	Sharing, co-use, reduce idle time, alternate use, redistribution, and product cascades.
5. Excess or harmful use	Preventative Strategies	Fundamentally prevent the use of a given material, substance or product.	Exclude from the system or to replace it with a benign alternative, smart material choices, lightweigthing, avoidance.

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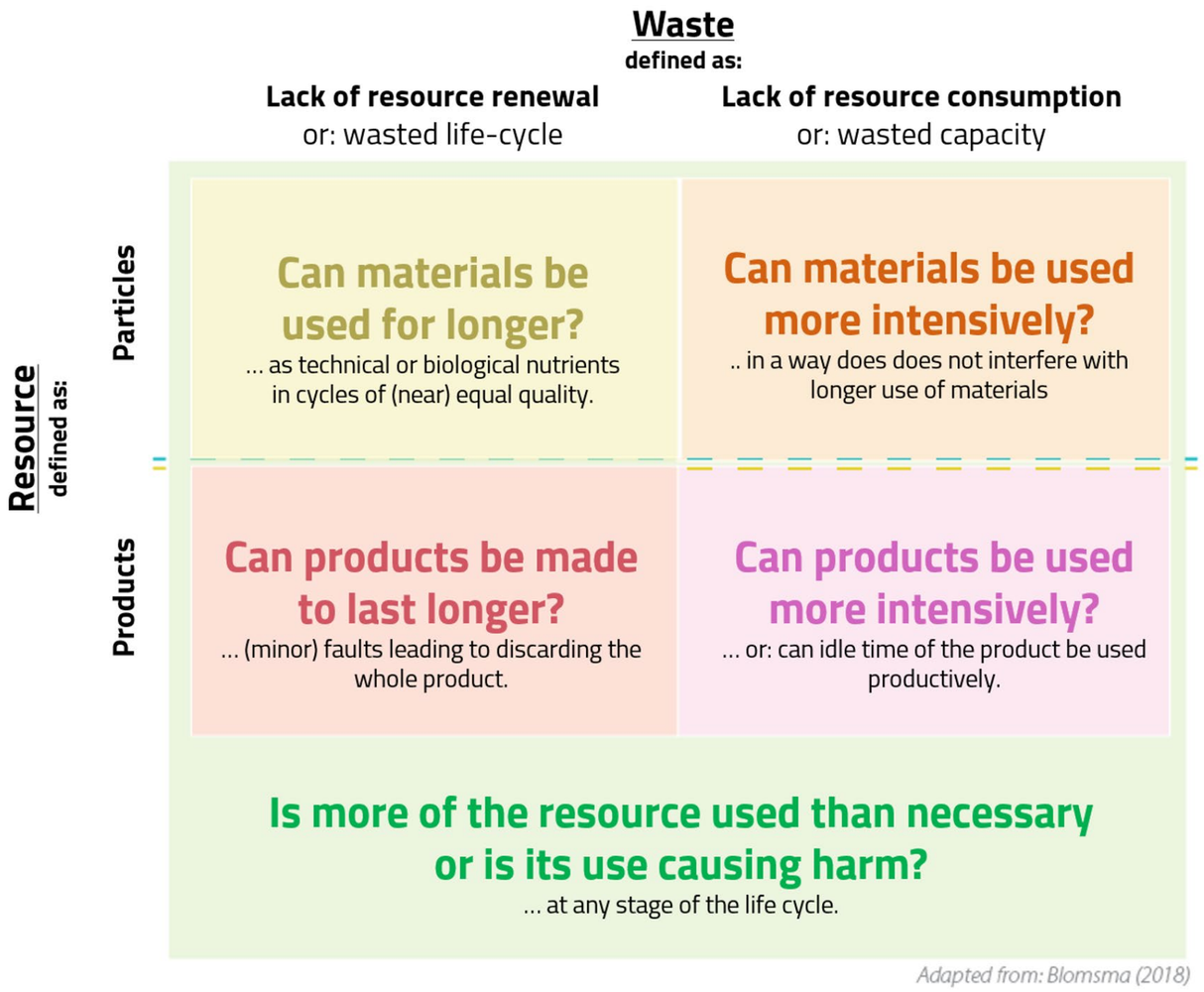
Big Five Structural Wastes | Structure

Keep in mind that multiple types of waste can present simultaneously. Likewise, multiple types can be addressed simultaneously, through the combined application of circular strategies. This can be done through applying multiple strategies at different places in the industrial life cycle.

It is important thinking in terms of these questions: where is the most important structural waste in the context that you are working with?



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How the Big Five Structural Wastes is used |
Step-by-step process

Use the Circularity Compass

You have already mapped your existing system and resource flows using the Circularity Compass.

Hunt the waste

Use the Circularity Compass with the mapped flows. Hunt for the five structural wastes by critically questioning the mapped resource flows (those that leave the system, but also within – think of underused capacity), using the five key questions of the Big Five tool.

Label the five wastes on the Compass

Label the wastes and types of wastes that you see on the Circularity Compass, using the five categories of waste of the Big Five tool.
Ask critical questions: WHY does each waste occur? What enables or amplifies it? What are the most important or impactful waste from the perspective of environment and economy? You can priorize your most important wastes

Think of circular strategies to remedy the wastes

Based on the different waste types and their priorities, ideate about the potential circularity strategies that can remedy each, using the five strategy types of the Big Five tool. Quantity over quality. This is a first collection.

Pre-organise the strategies

As a first overview, map the strategies along the Value Hill and conduct a first prioritization. Can you make connections or do you already identify useful strategy combinations?

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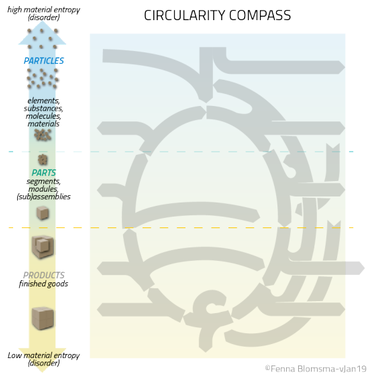
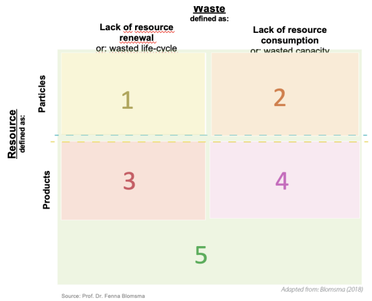
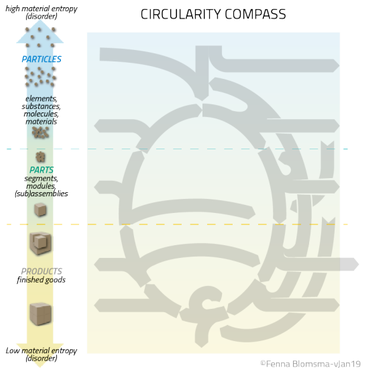
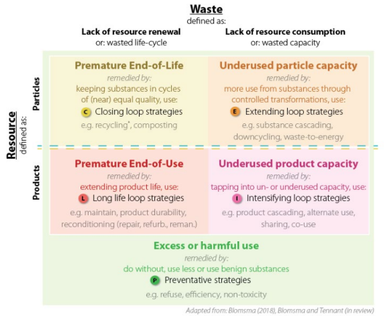
How the Big Five Structural Wastes is used |
Step-by-step process

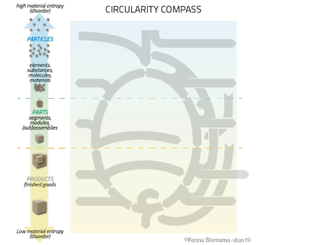
Use the Circularity Compass → **Hunt the waste** → **Label the five wastes on the Compass** → **Think of circular strategies to remedy the wastes** → **Pre-organise the strategies**

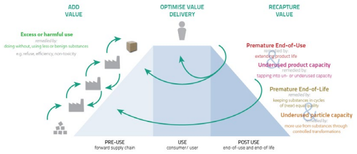












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How to use the tool – case example

Find inspiration on real life case examples how the tools can help to develop circular solutions on the following pages. These include some examples developed by the project team and some developed by training participants during the delivery of Circularity Thinking training courses.

Disclaimer: none of the companies mentioned in any of our case examples made their own use of the Circularity Thinking tools. We applied the tools in hindsight and based on available information of the companies. We only show how the Circularity Thinking tools can be applied on company cases to support the circular innovation process.

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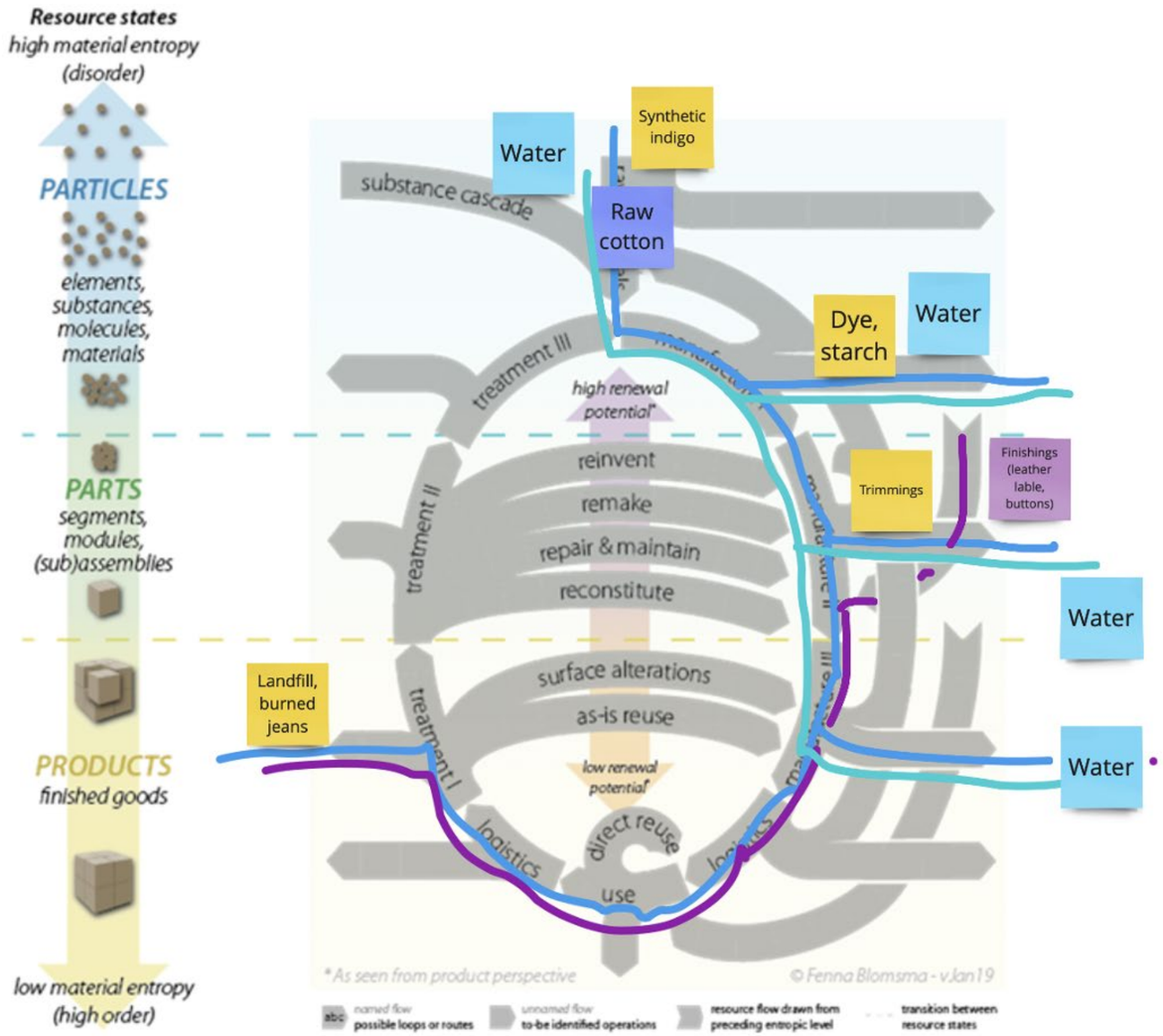
Fill in the Circularity Compass →



Here is a *simplified** example of the material flows within the lifetime of an industry standard pair of jeans.

View this as ‘MUD Jeans before they adopted circularity strategies’.

*Emphasis lies on “simplifed“ – the purpose here is to demonstrate the use of the Big Five tool rather than make a comprehensive analysis.

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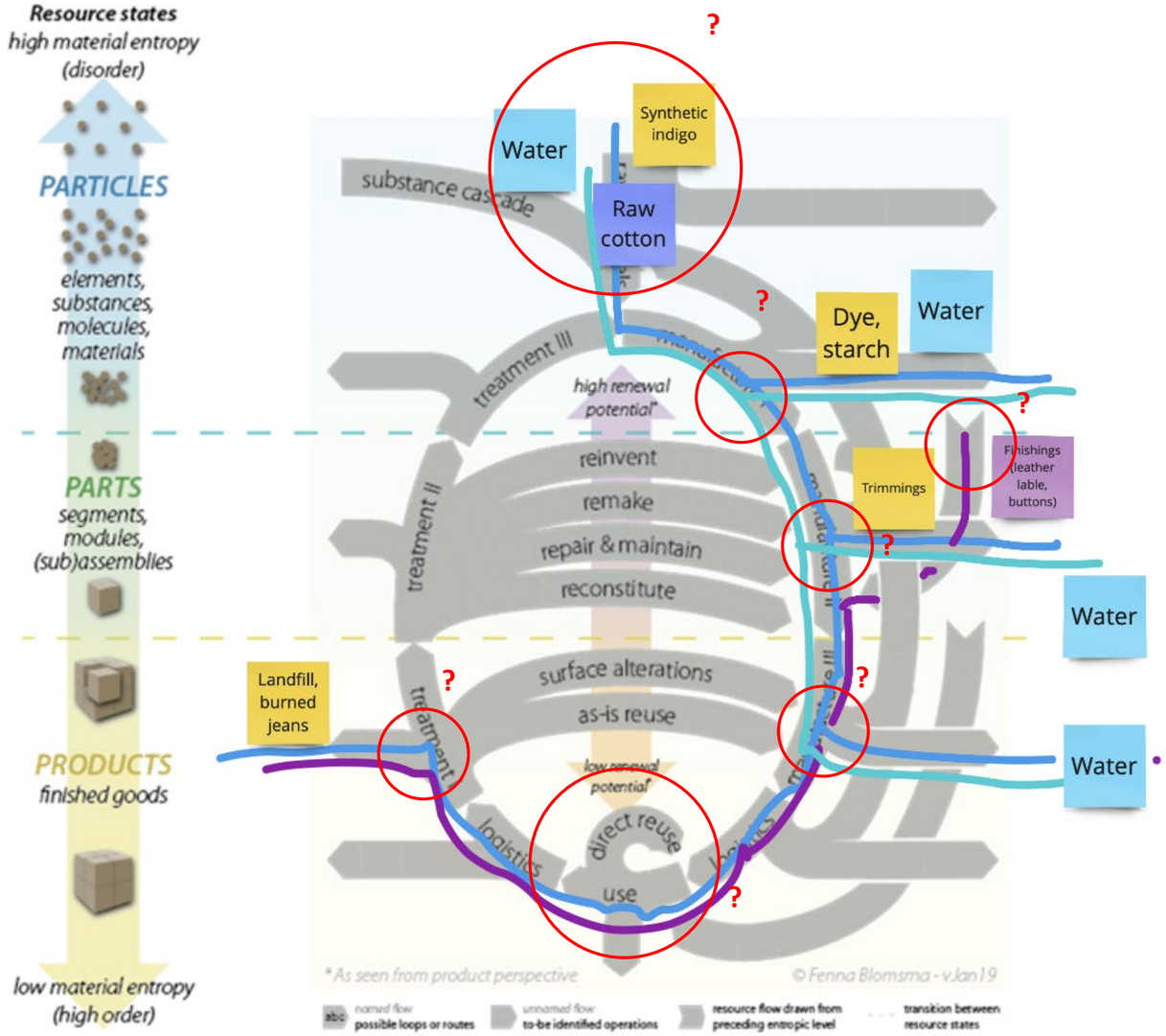
Use the Circularity Compass → **Hunt the waste** →

This is where the Big Five Structural Wastes comes in – applying it to the material flows within the mapped system and questioning points where materials exit the system or new materials enter.



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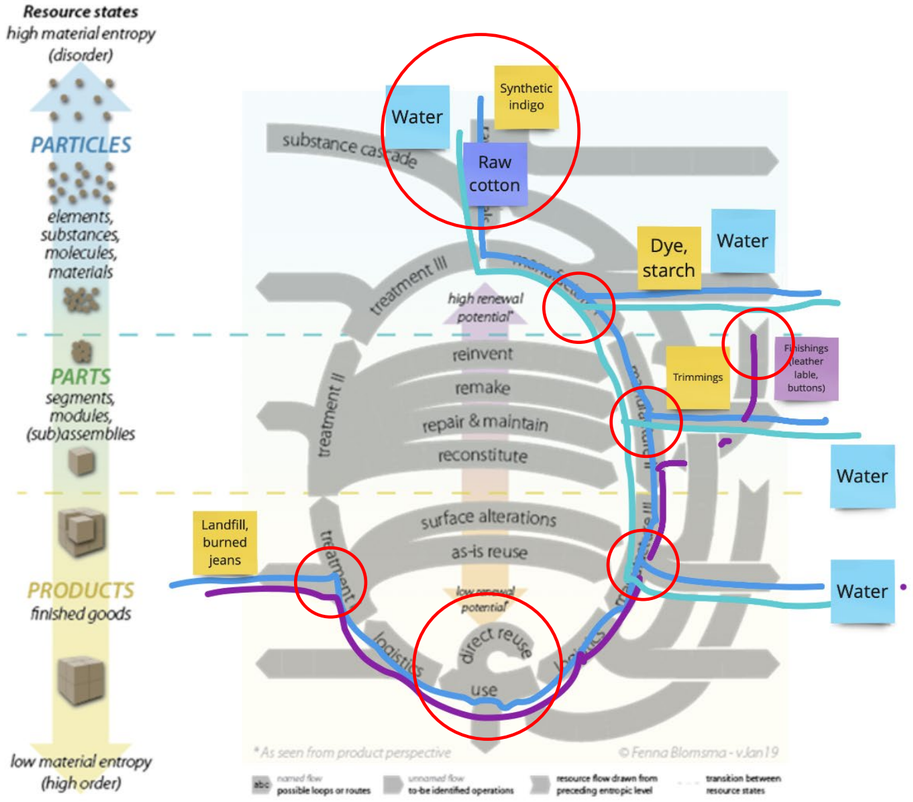
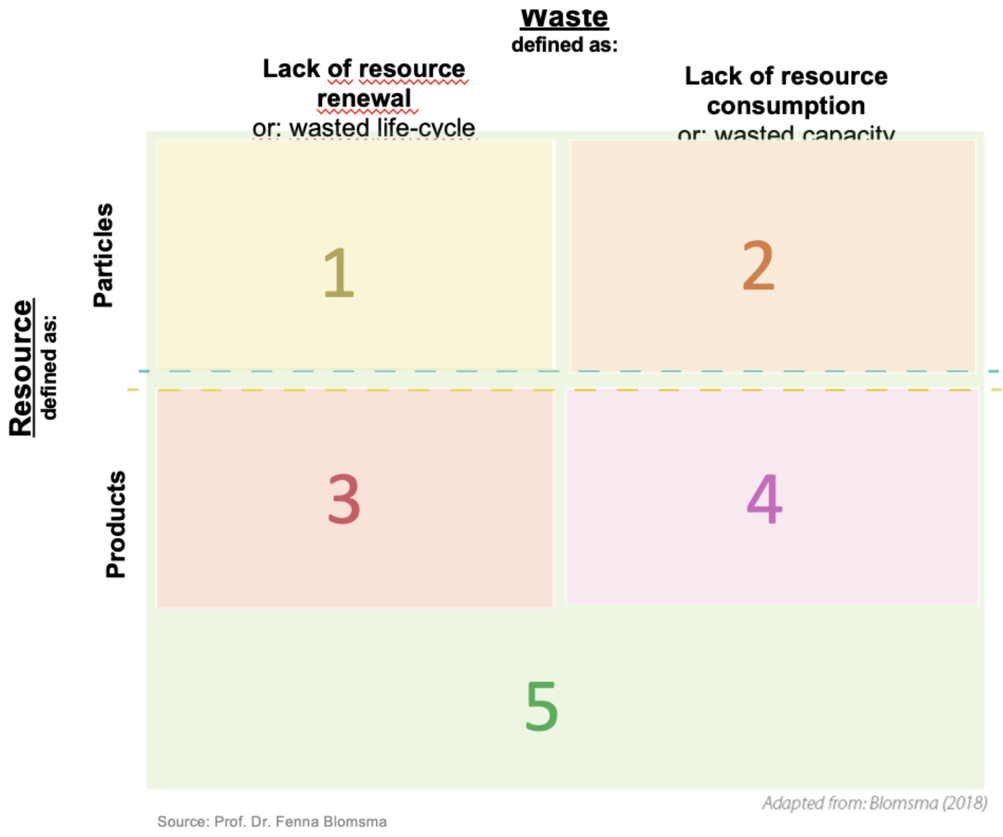
Use the Circularity Compass → **Hunt the waste** → **Label the five wastes on the Compass** →





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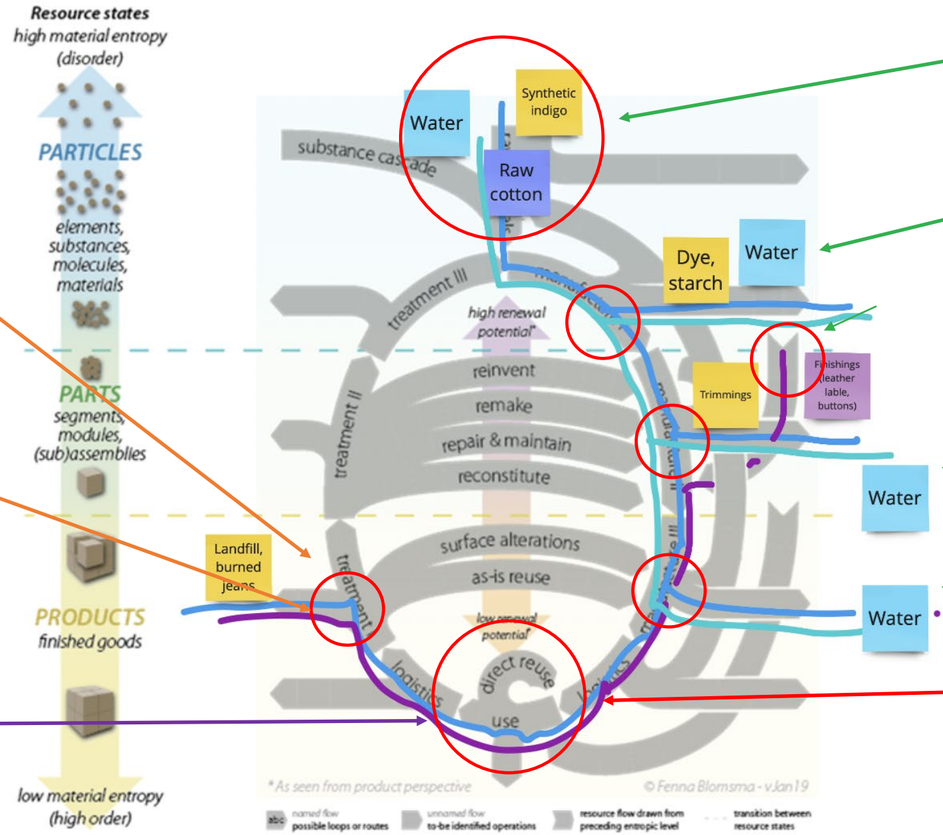
Use the Circularity Compass → **Hunt the waste** → **Label the five wastes on the Compass** →

1.
Denim material not typically reused for new jeans or other products.

2.
Denim typically thrown away and burnt.
Leather patches and buttons are not reused and thrown away with jeans and burnt.

4.
Some jeans are only worn a couple of times whilst in possession, then are thrown away (e.g. because they are not stylish anymore).



5.
Exclusively using virgin cotton.
Heavy water consumption.
Heavy synthetic Indigo use.

5.
Continued use of water.
Dirty water washed away.
Synthetic dyes washed away.

5.
Use of leather patches for back of jeans.

5.
Continued use/waste of water.
Dirty water washed away.

3.
Jeans are not stylish anymore, not resold for further use.
Jeans are not typically repaired if damaged.

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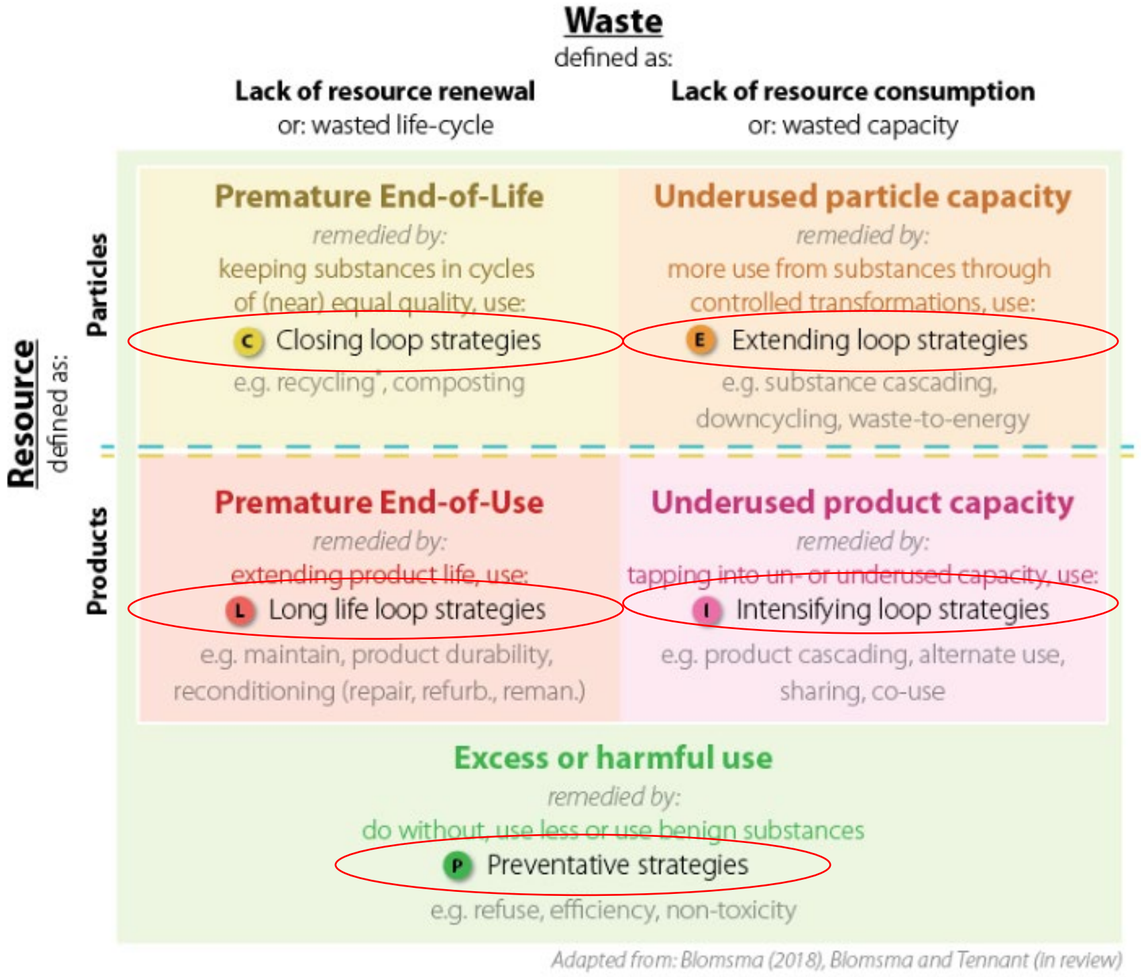
Use the Circularity Compass → Hunt the waste → Label the five wastes on the Compass → Think of circular strategies to remedy the wastes →



Note:

At this point, we would usually only point out that we can address the present waste with, for example, ‘extending loop strategies’, as we do not know nearly enough about the product system and the context yet. A formulation of a concrete strategy would start in the next step.

Here, we are looking in hindsight at a company that already found good solutions. Therefore, in the next slides we describe the solutions in more detail already. So, instead of ‘extending loop strategy’ we state that the company went with e.g. ‘repair’.

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Preventative Strategies:

(A) Ceasing use of leather and replacing with non—toxic print on labels.

(B) MUD Jeans production methods mean they use notably less water to produce a single pair of jeans than the industry average. They also do this by offering jeans which contain less dye, a major source of water usage. Less water is used throughout the rest of the process.

Closing Loop Strategies:

(A) 95% of the water used in the production process of the denim is reused.

Long Life Loop Strategies:

(A) MUD Jeans offer a repair service for the jeans which they sell. This is free for the first 12 months.

(B) The lease of jeans offered by MUD ensures that the maximum value is extracted from a pair of jeans and prevents them being used just a couple of times before being thrown in the cupboard and never reused.

Closing Loop Strategies:

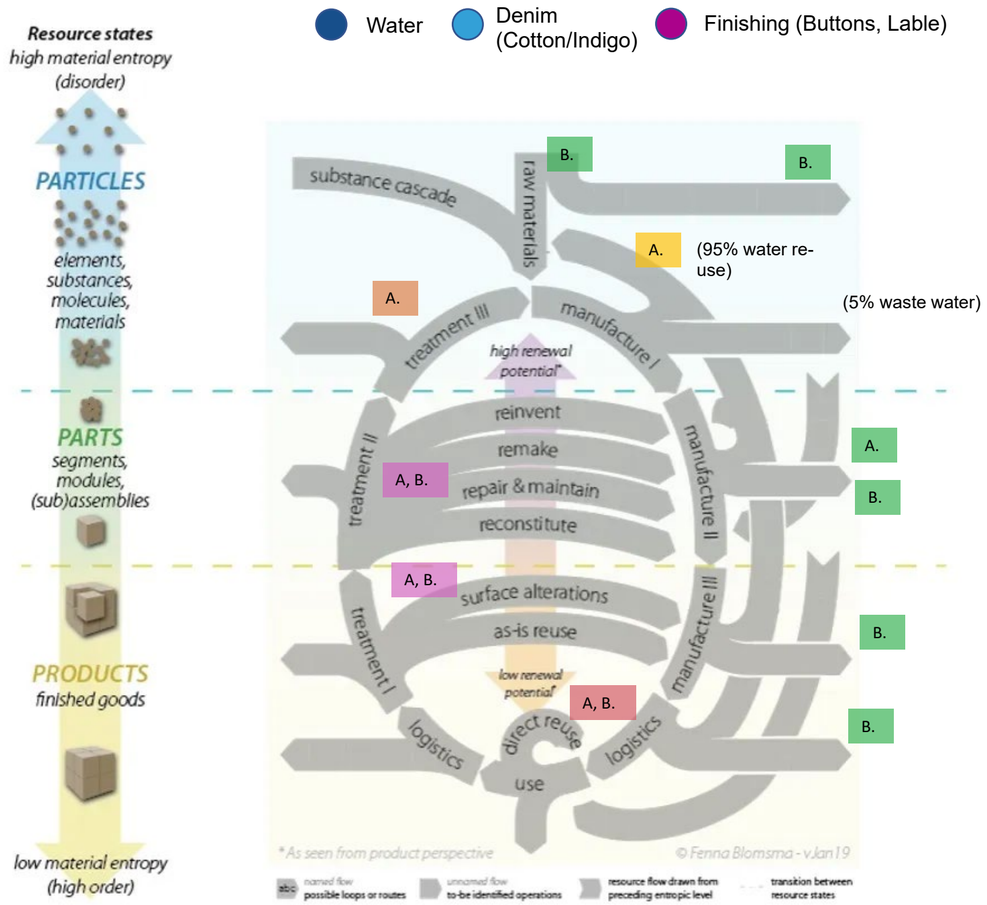
(A) Although there is a maximum level of recycled content to make new yarns for jeans, MUD Jeans recycle 23-40% of their denim for manufacturing new jeans.

(B) MUD Jeans do not disclose how any other waste denim is reused or treated. Does the 23-40% recycled content equate to the quantity of jeans returned to the system by the user?

Intensifying Loop Strategies:

(A) For jeans which have been returned to MUD for recycle, or have been leased, but require repairs, MUD will wash/repair them as necessary and resell the jeans as ‘vintage’ i.e used.

(B) MUD Jeans also offer a leasing service on their jeans, where the users pays monthly and returns them when they want a new pair.



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Observations and open questions

- Big Five Structural Wastes and the Circularity Compass provide a practical means of mapping an existing system, identifying material flows and locating structural wastes or inefficiencies.
- It must be noted that the example included here is a high-level overview. In reality, the goal would be to re-iterate and dig even deeper into the supply chain, and account for factors such as energy consumption (these too are resources/inefficiencies).
- One can also ask themselves still, what proportion of MUD users actually return their jeans after use? How extensively used is their repair service relative to the total number of jeans sold? Understanding these dynamics may allow for further improvements to the MUD Jeans system.
- What this example also shows is that there is perhaps a limit to how circular we can go – the point being, there may be some forms of inefficiency in a system which are not financially viable or practical to resolve. By applying the Circularity Grid tool, this may help answer this.

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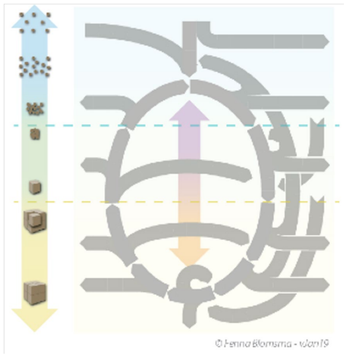
Connection to other tools

Circularity Compass



Map the resource flows

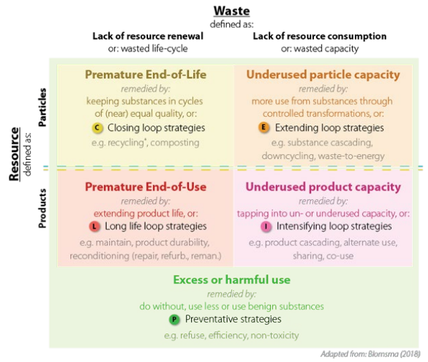
The Circularity Compass is at the very heart of the Circularity Thinking Tools. We **use it all the time** along the innovation process and for different purposes.

The Circularity Compass helps us to map any resource flows of e.g. product systems – current ones or those of our new and shiny circular solutions.

We **also use it as starting point** of the Circularity Thinking process, where we first of all map the resource flows of a certain (product) system as they are. And this is also the purpose at the core of this introductory explanation. Everything else you will learn in the training.

input

Big 5 Structural Wastes



Hunt the waste

We know, what the resource flows of the current (product) system look like. Now we are going to hunt the waste.

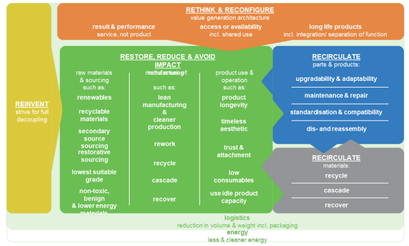
First, we learn what waste actually is.

Then we find out what is actually wasteful along the value chain and what kind of waste is hidden. We also learn, which strategies can address this specific kind of waste.

The better we understand the waste, the better we can address it effectively and with an appropriate combination of circular strategies.

output

Circular Strategy Scanner



Identify suitable circular strategies
In the last step, we have identified circular strategies that are potentially a good match to go about the waste in our product system. But this is yet just a random collection of potential individual strategies.

Now we have a closer look. What particular strategies are at our disposal and can we prioritise? Which strategies are on product level and which on system level. Can we combine strategies and how can they support each other?

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