

# The circular supermarket chain

Introducing the Circular Economy in the Building Specification



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06-07-2018

# Background



# The Lidl and circularity

Building industry is responsible for 50% all waste.

# The Lidl and circularity

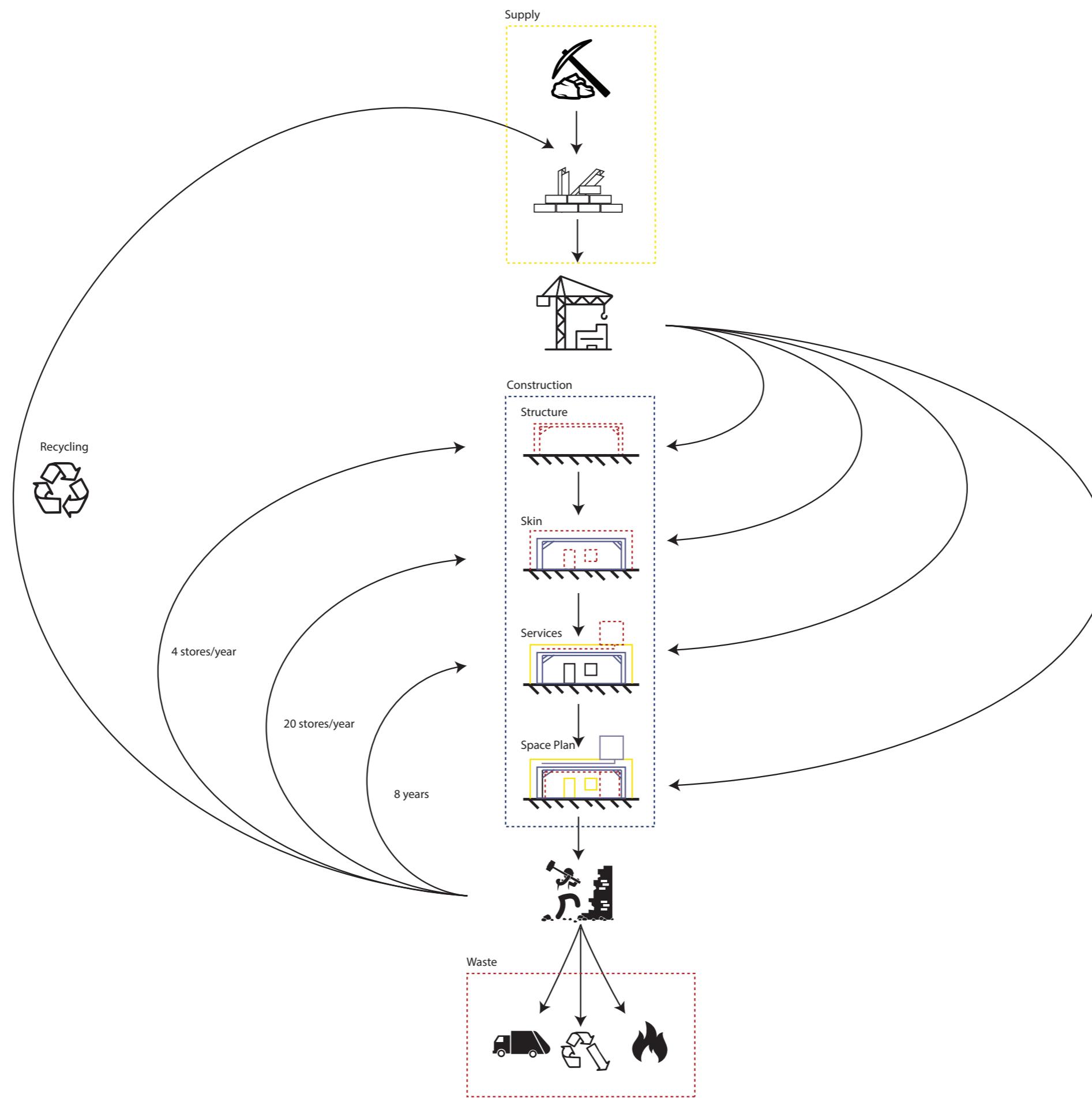
415 Stores



Small  
renovation  
8 years

large  
renovation  
20 years

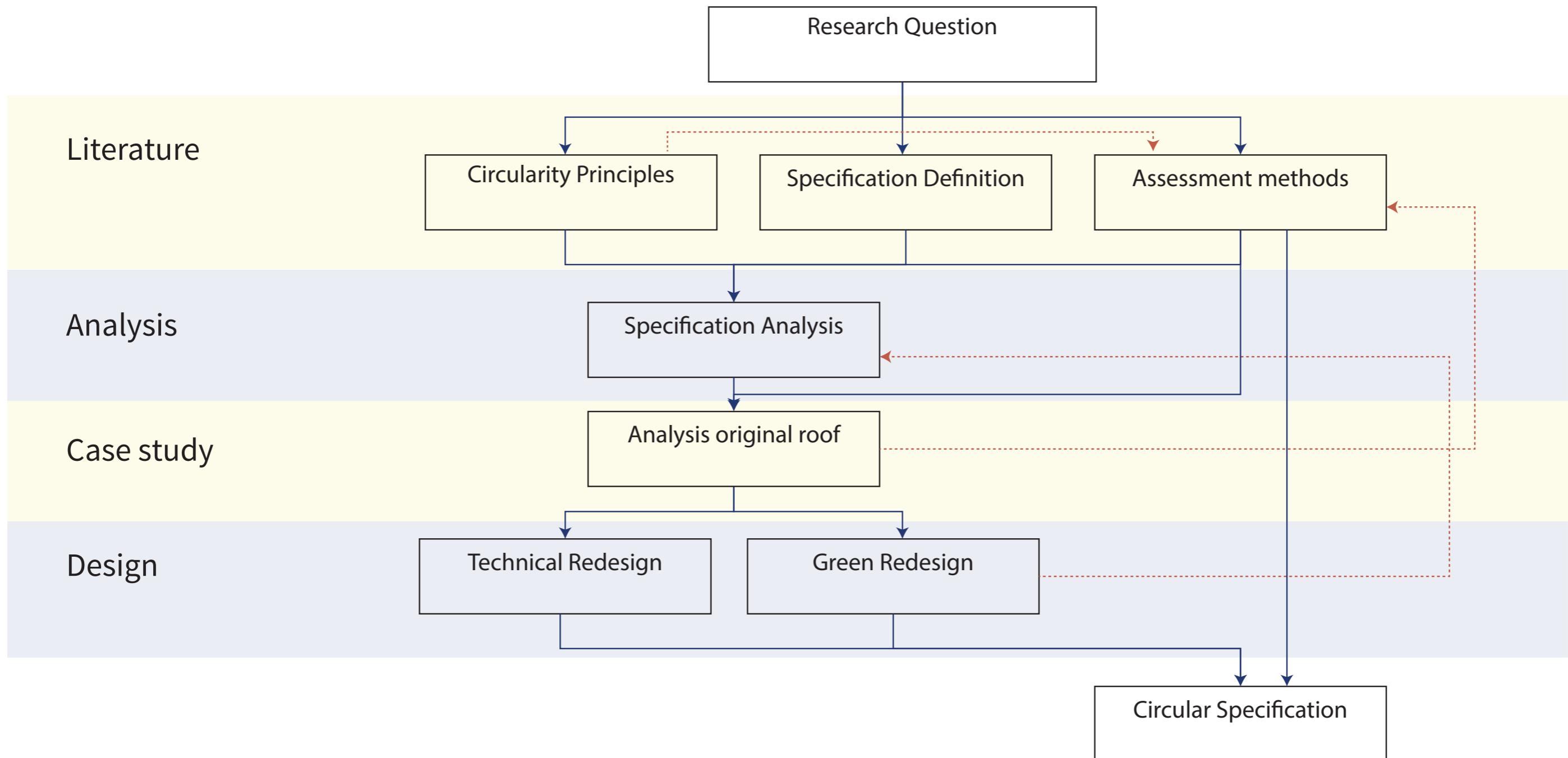
# The Lidl and circularity



# Main question

*Which changes have to be made to make the Lidl's Specification circular, with an emphasis on materials and assembly?*

# Methodology



# Objective

1. Assessment method
2. Specification analysis
3. Changes to the Lidl's Specification to make it circular

# Principles of the Circular Economy

What are the principles for circularity in the built environment?

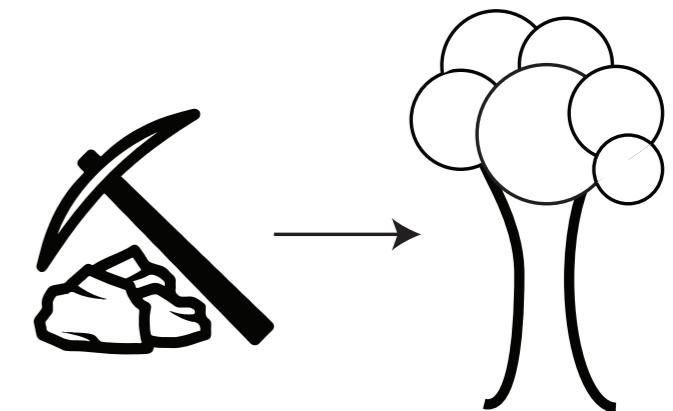
# Principles of the Circular Economy



Eliminate waste

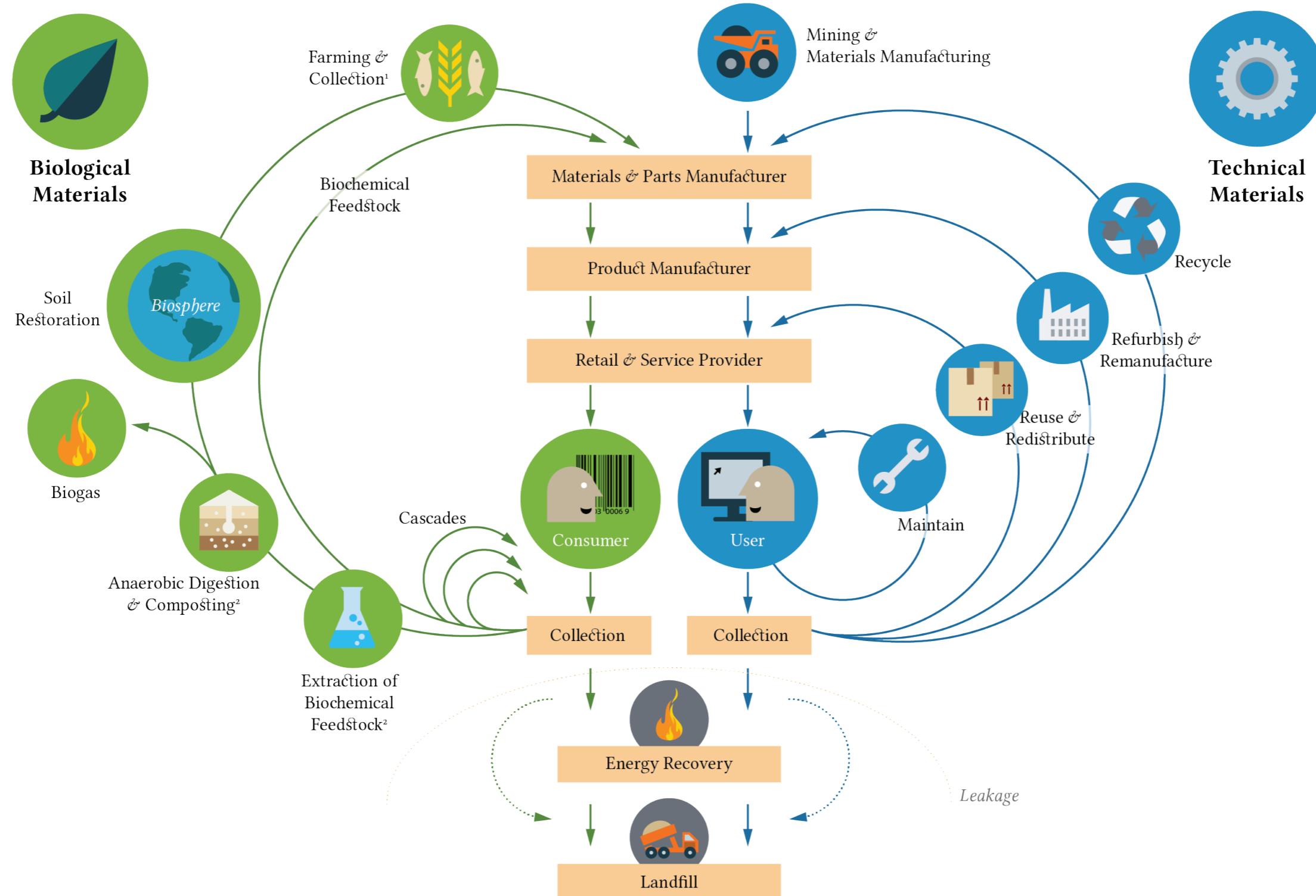


Maintain value



Employ  
renewable  
sources

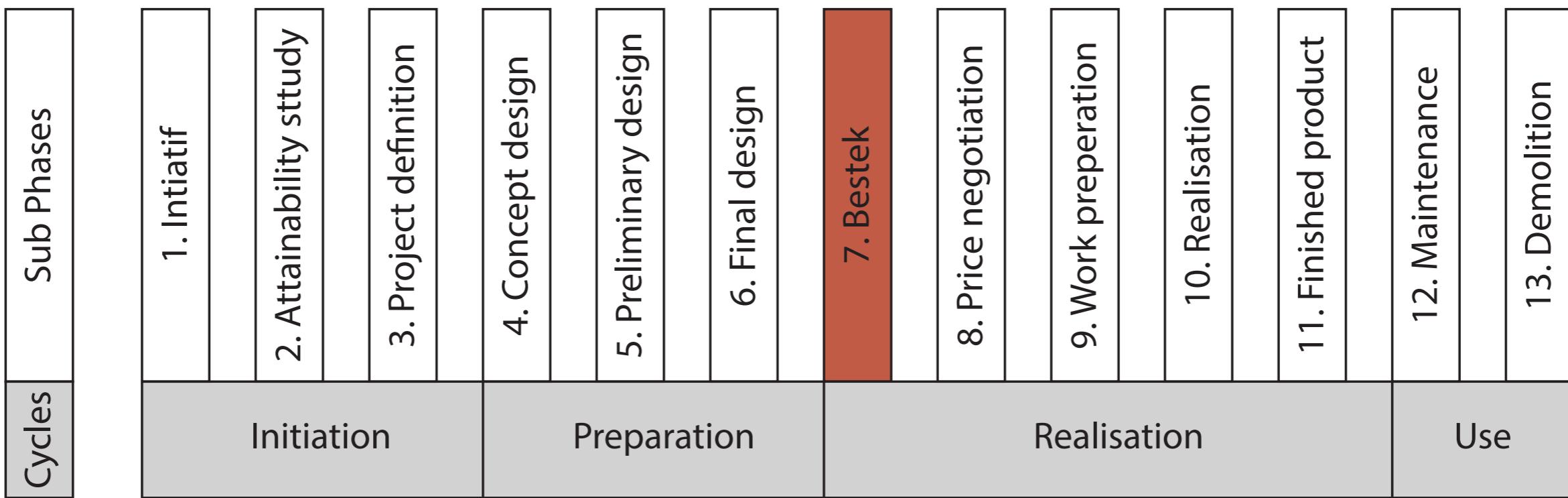
# Principles of the Circular Economy



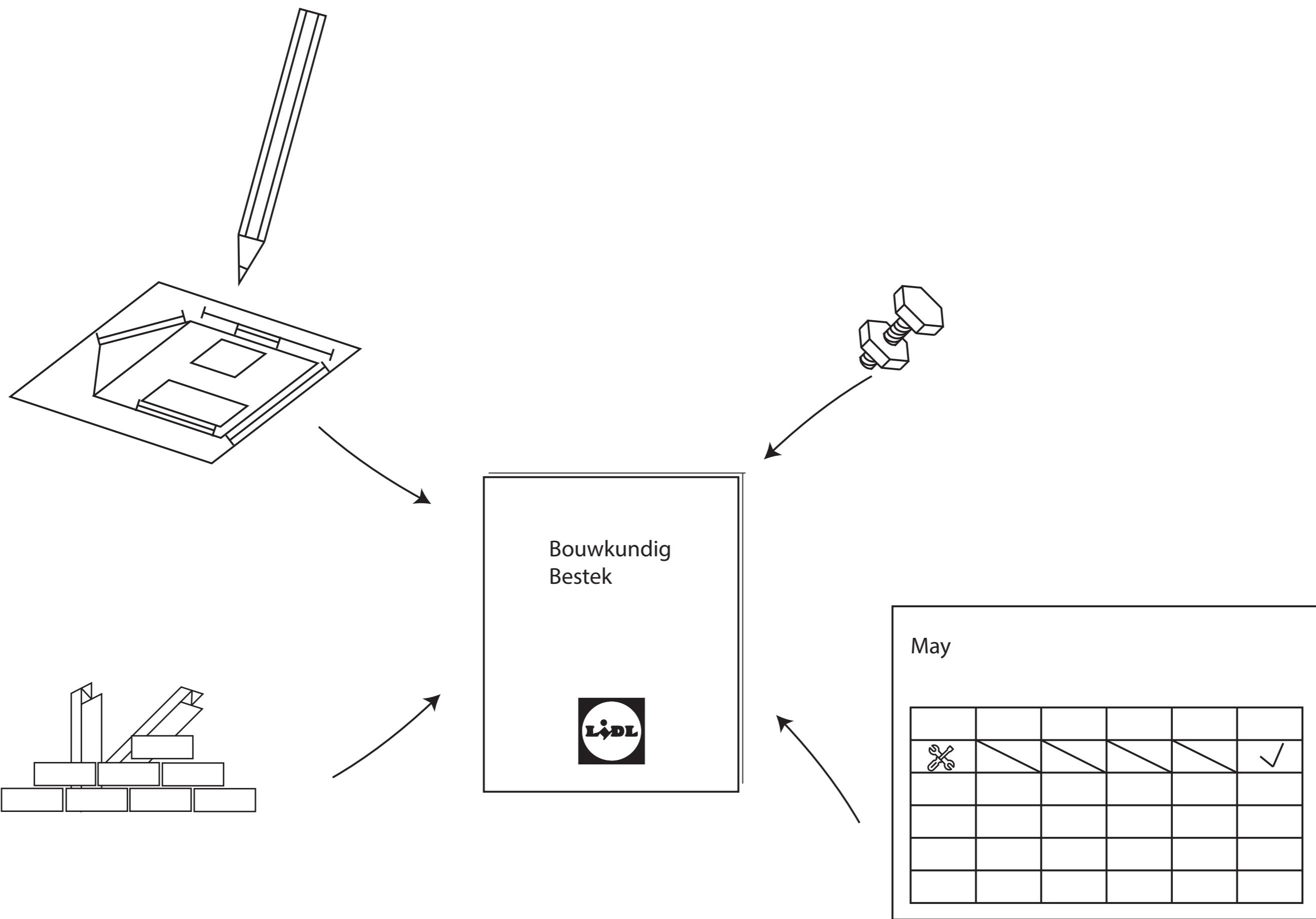
# Dutch Specification

How is the Dutch Specification currently implemented?

# Dutch Specification



# Dutch Specification

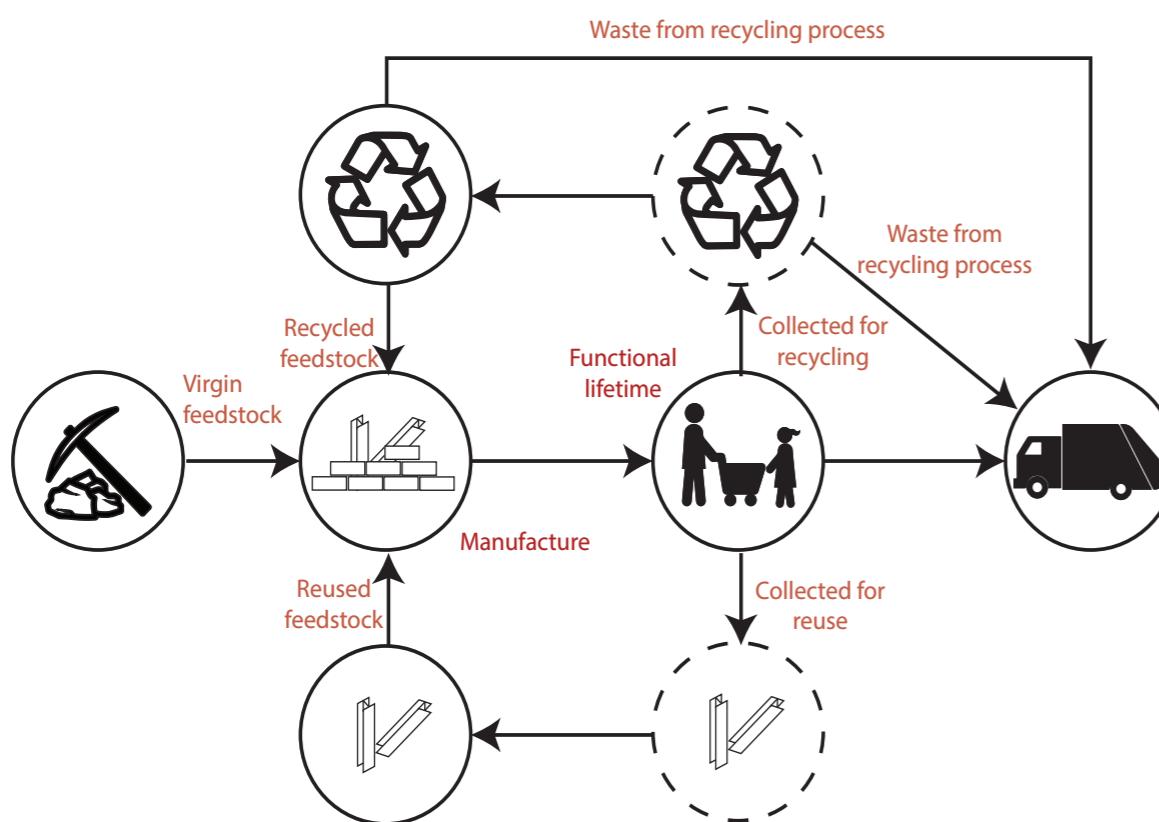


# Assessment Methods

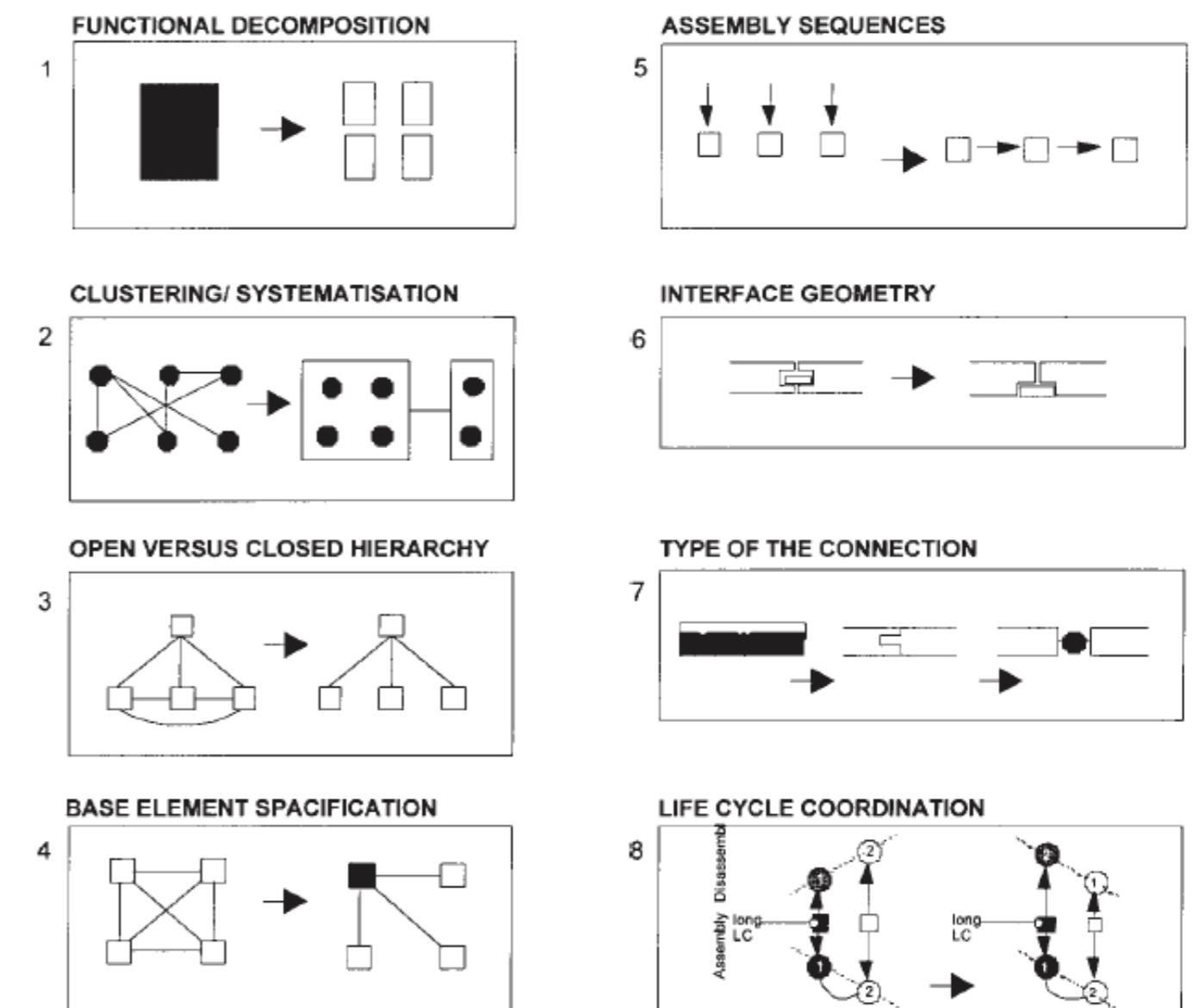
What are the current methods to assess the level of circularity in building designs?

# Assessment Methods

## Material Circularity Indicator



## Disassembly Potential



# Specification Analysis

What are the circular bottlenecks in the current Lidl's Specification?

# Specification Analysis



**SITE**

- 10 - Stut- en sloopwerken
- 12 - Grondwerk
- 13 - Bemaling
- 14 - Buitenriolering en drainage

**STRUCTURE**

- 20 - Funderinspalen en damwanden
- 21 - Betonwerken
- 22 - Metselwerken
- 24 - Ruwbouwtimmerwerk
- 25 - Metalen draagconstructies

**SKIN**

- 30 - Kozijnen ramen en deuren
- 31 - Systeembekleding
- 33 - Dakbedekking
- 34 - Beglazing
- 35 - Natuur- en kunststeen
- 37 - Isolatie
- 38 - Gevelschermen
- 40 - Stukadoorwerken
- 25 - Metalen draagconstructies

**SERVICES**

- 51 - Binnenriolering
- 52 - Waterinstallaties
- 53 - Sanitair
- 54 - Brandbestrijdingsinstallaties

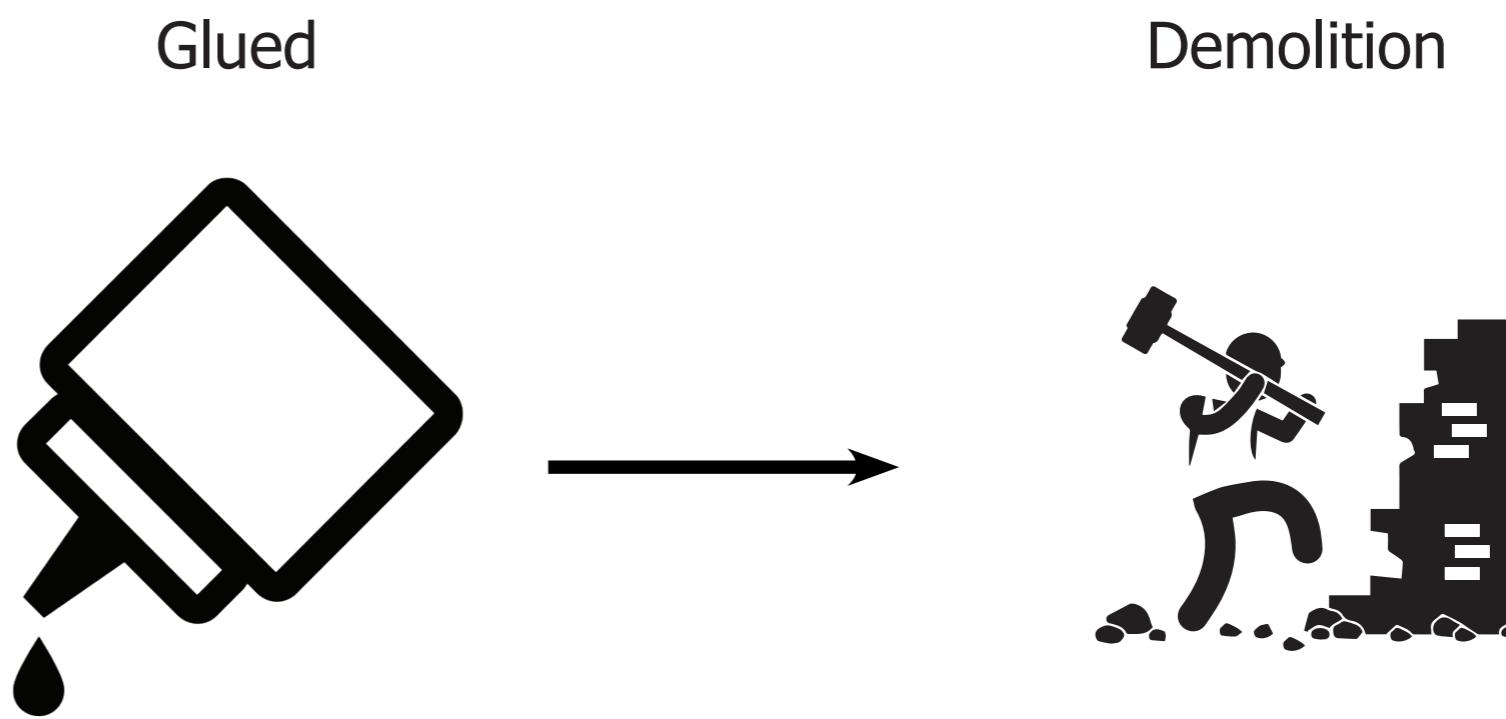
**SPACEPLAN**

- 41 - Tegelwerken
- 42 - Dekvloeren en vloersystemen
- 43 - Metaal- en kunststofwerken
- 44 - Plafond- en wandsystemen
- 45 - Afbouwtimmerwerk
- 46 - Schilderwerk
- 48 - Vloerbedekking
- 22 - Metselwerken
- 24 - Ruwbouwtimmerwerk

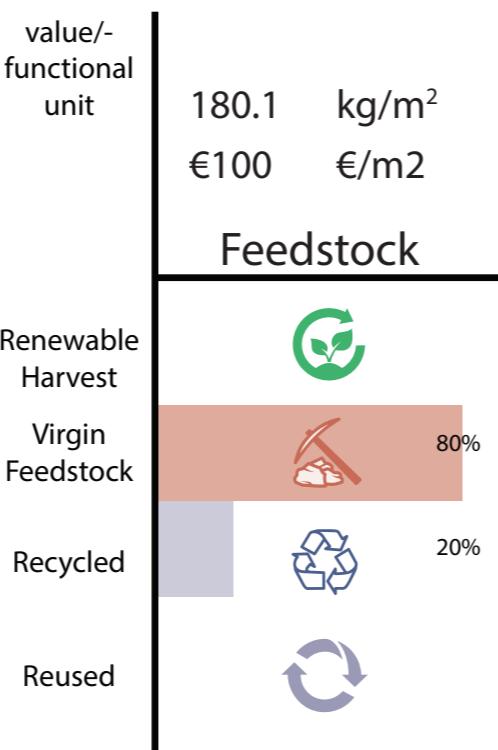
# Sand-lime brick



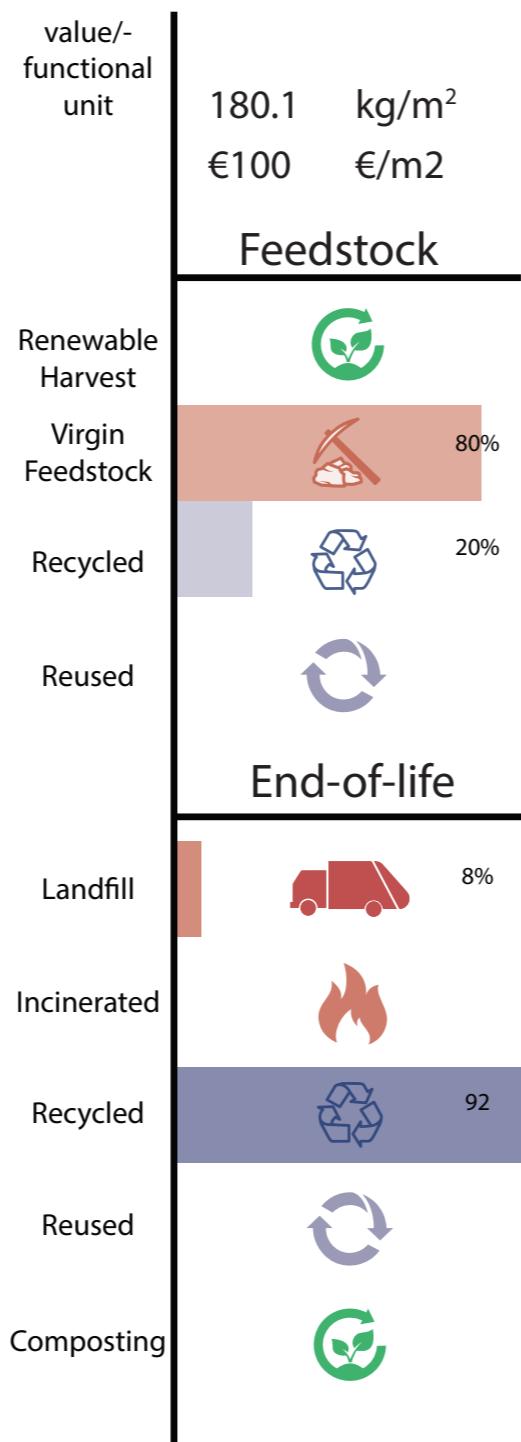
# Sand-lime brick



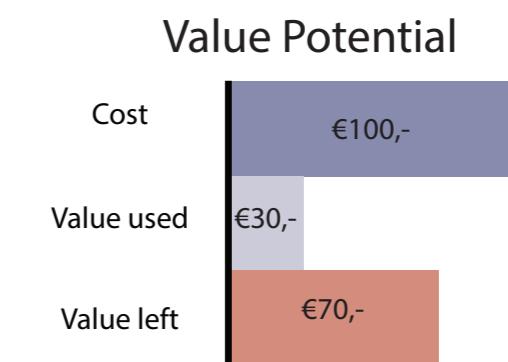
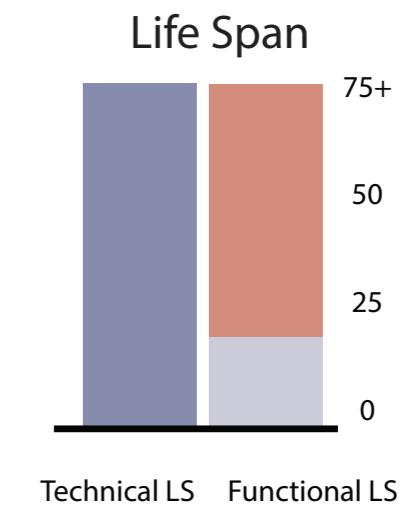
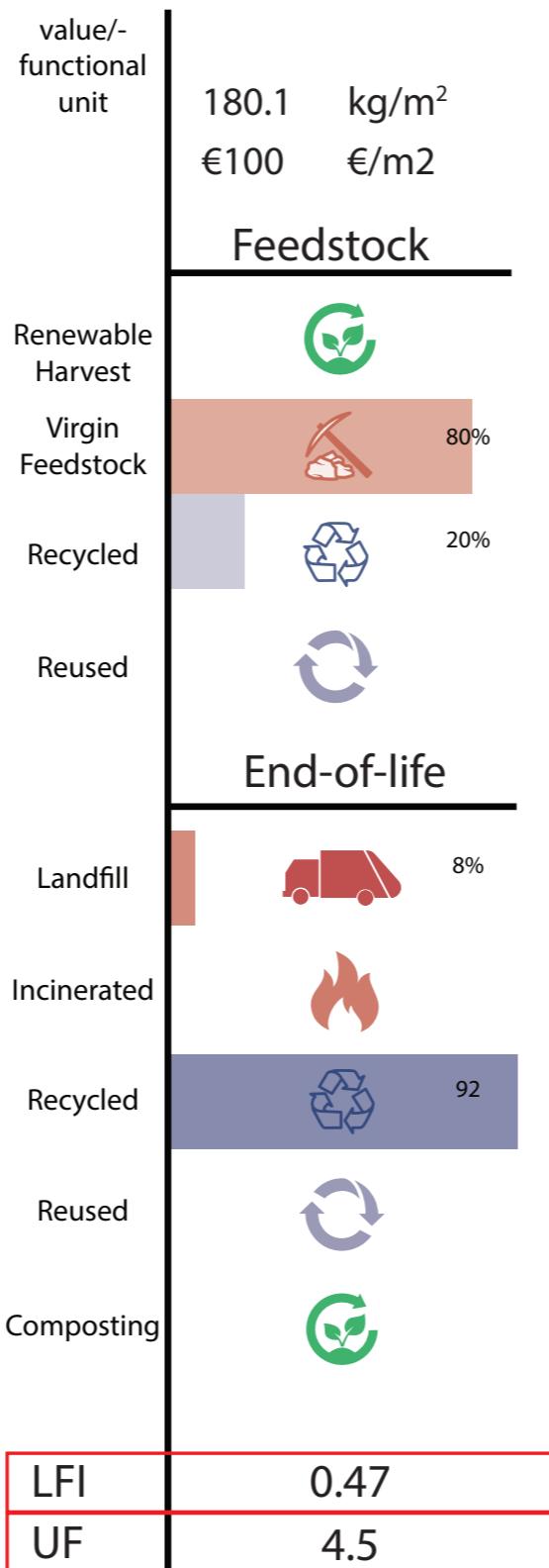
# Sand-lime brick



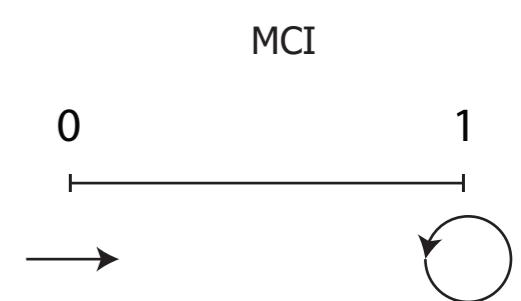
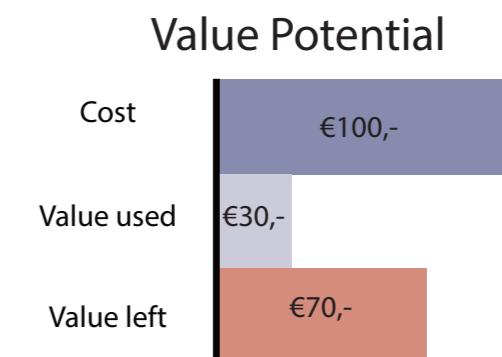
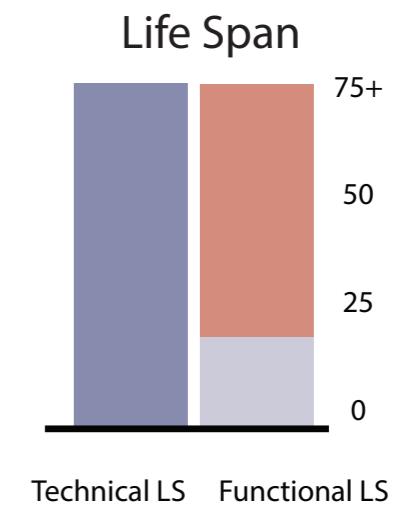
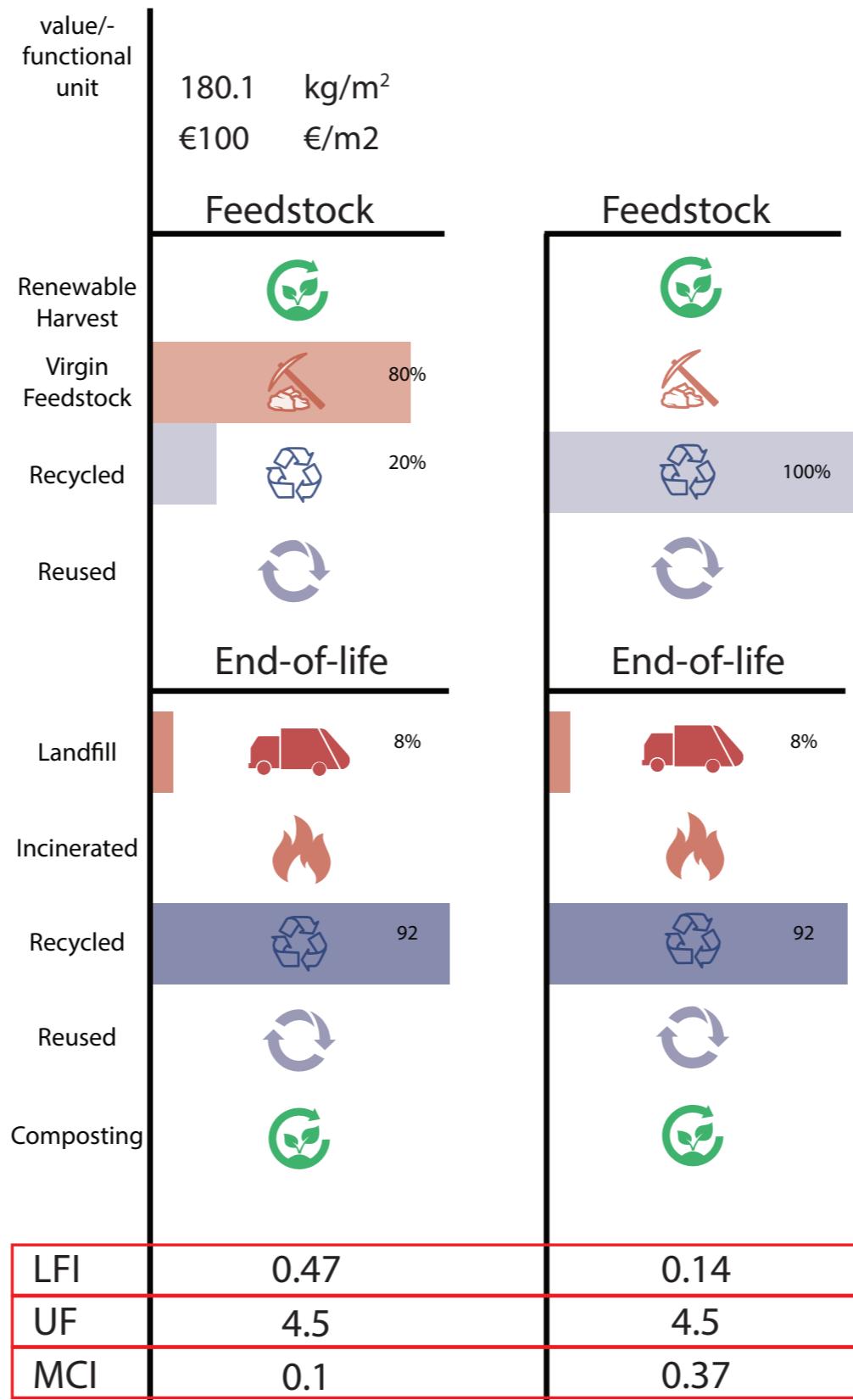
# Sand-lime brick



# Sand-lime brick



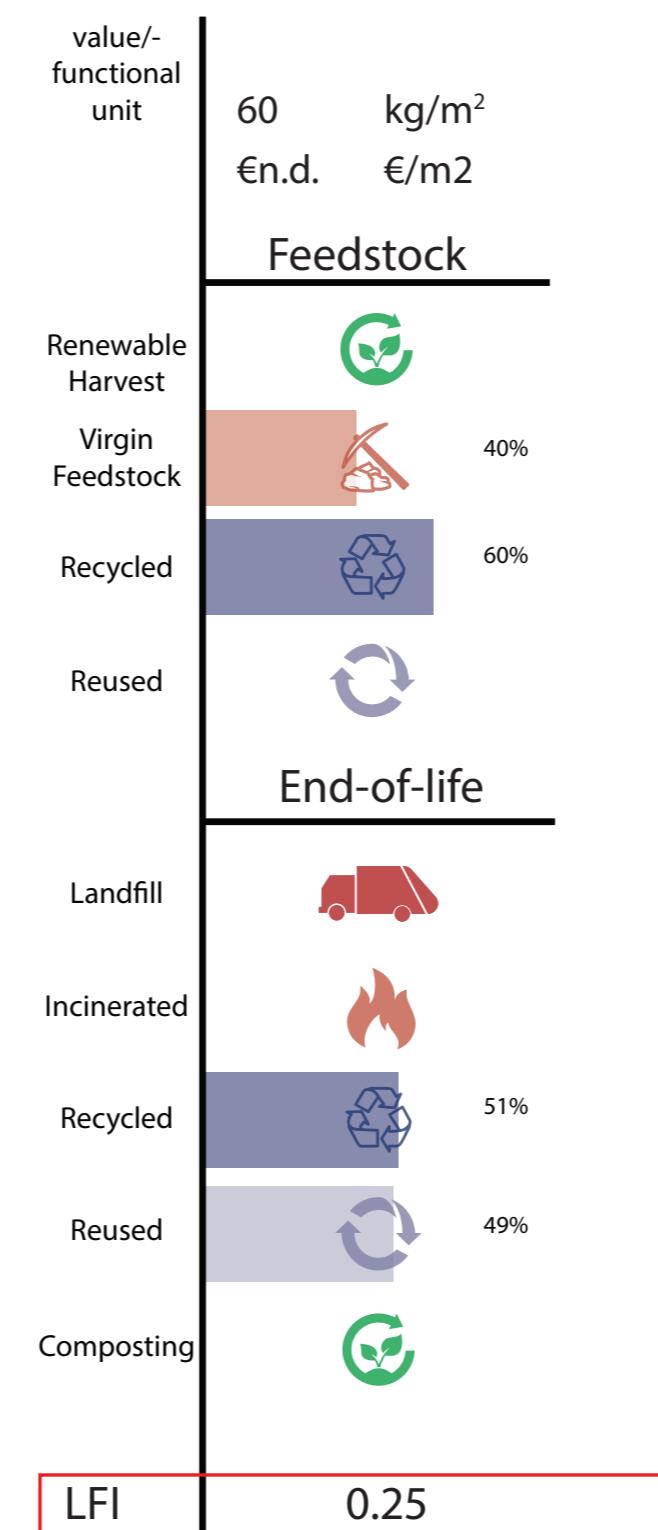
# Sand-lime brick



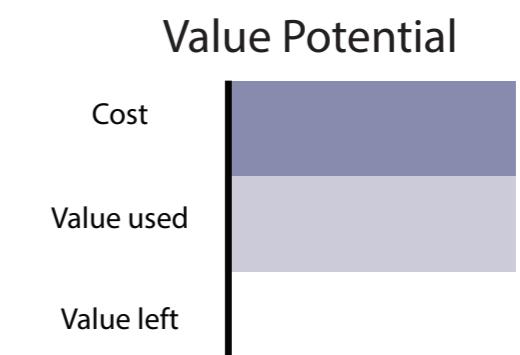
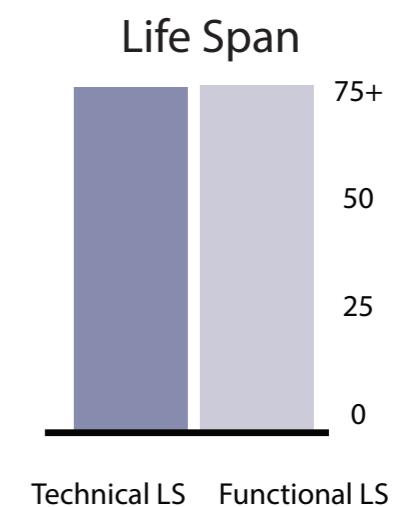
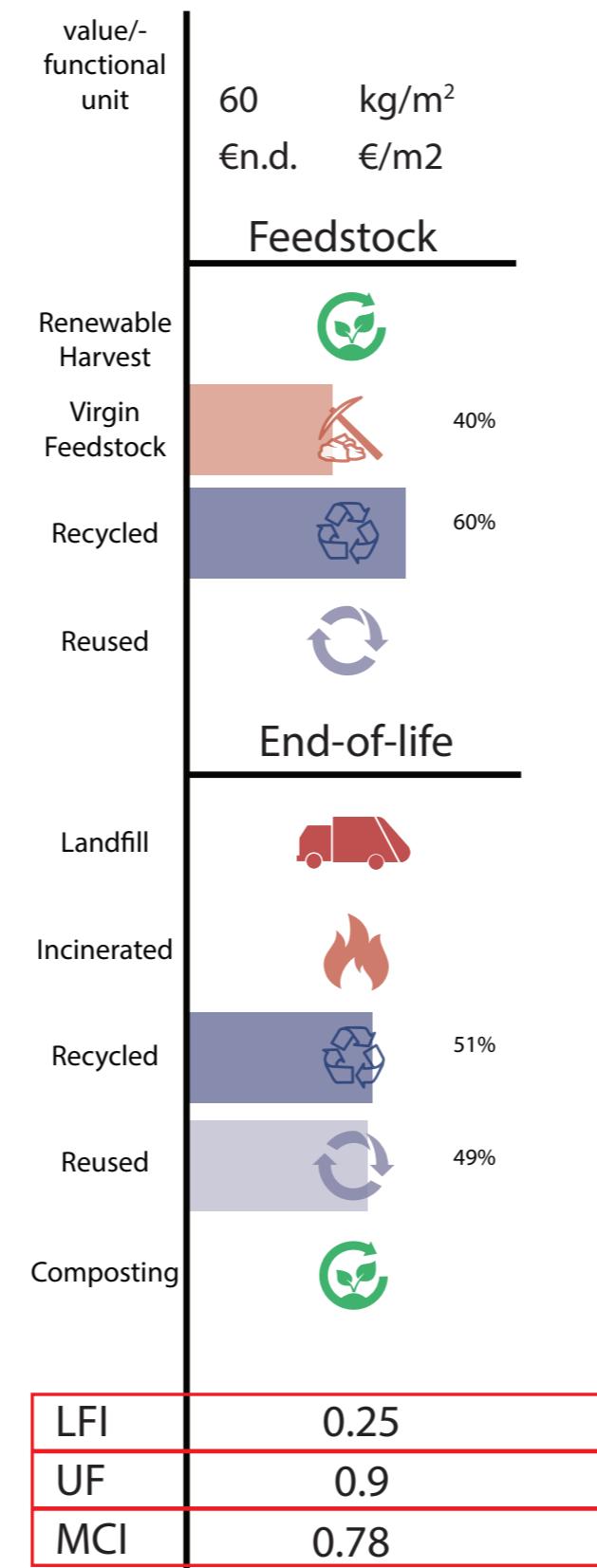
# Steel beams



# Steel beams



# Steel beams



Introduction

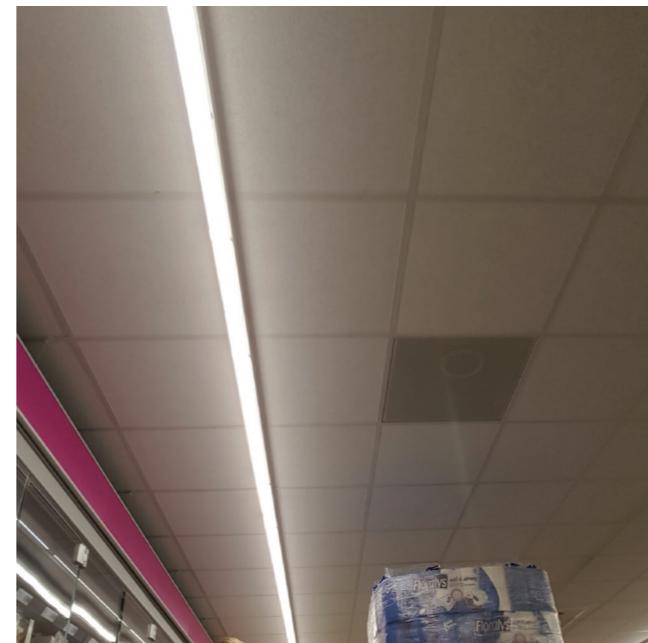
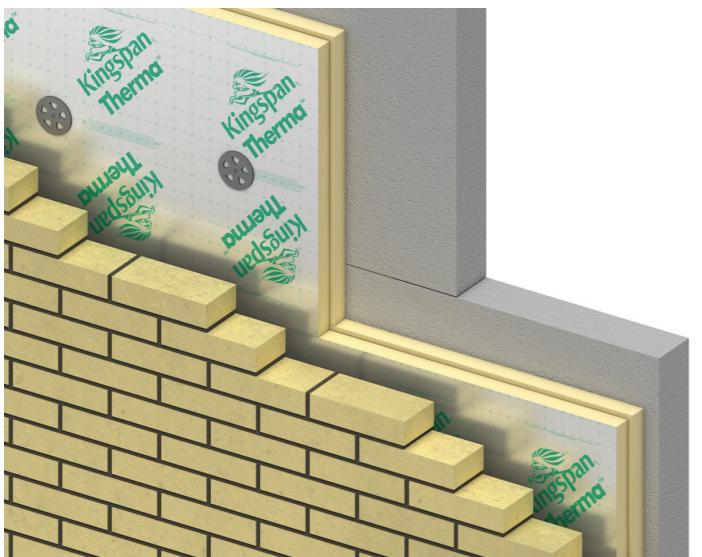
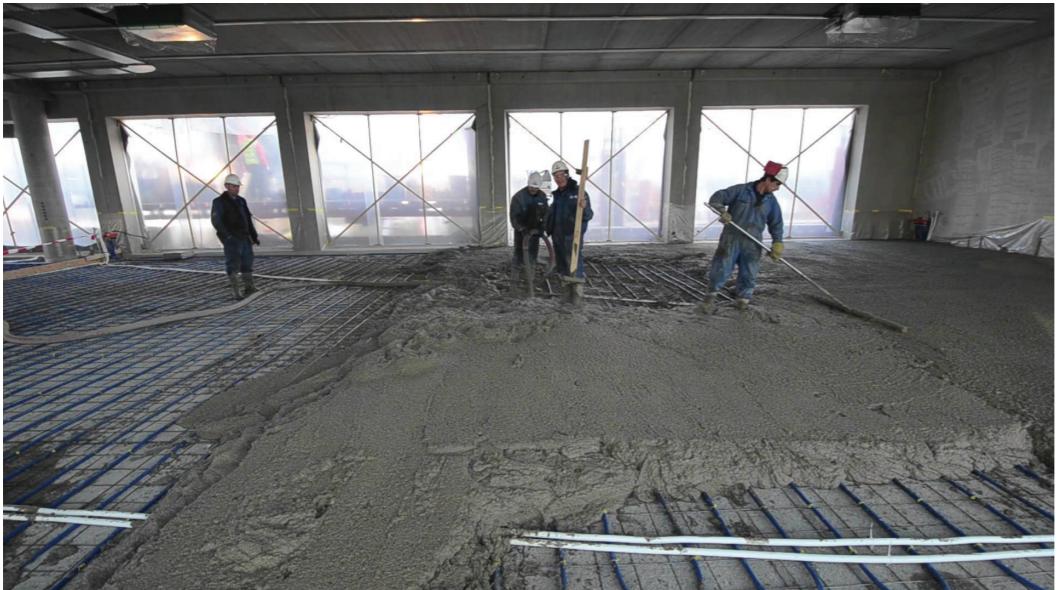
Analysis

Case study

Redesign

Reimplementation

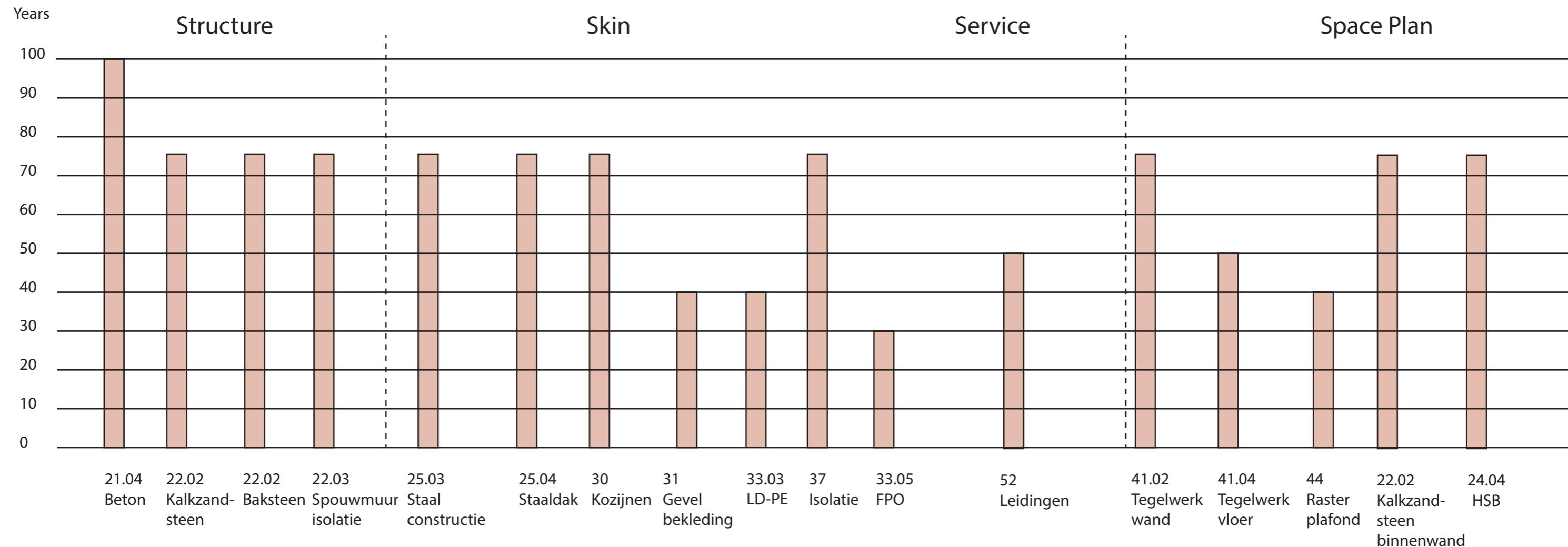
# Analysed materials



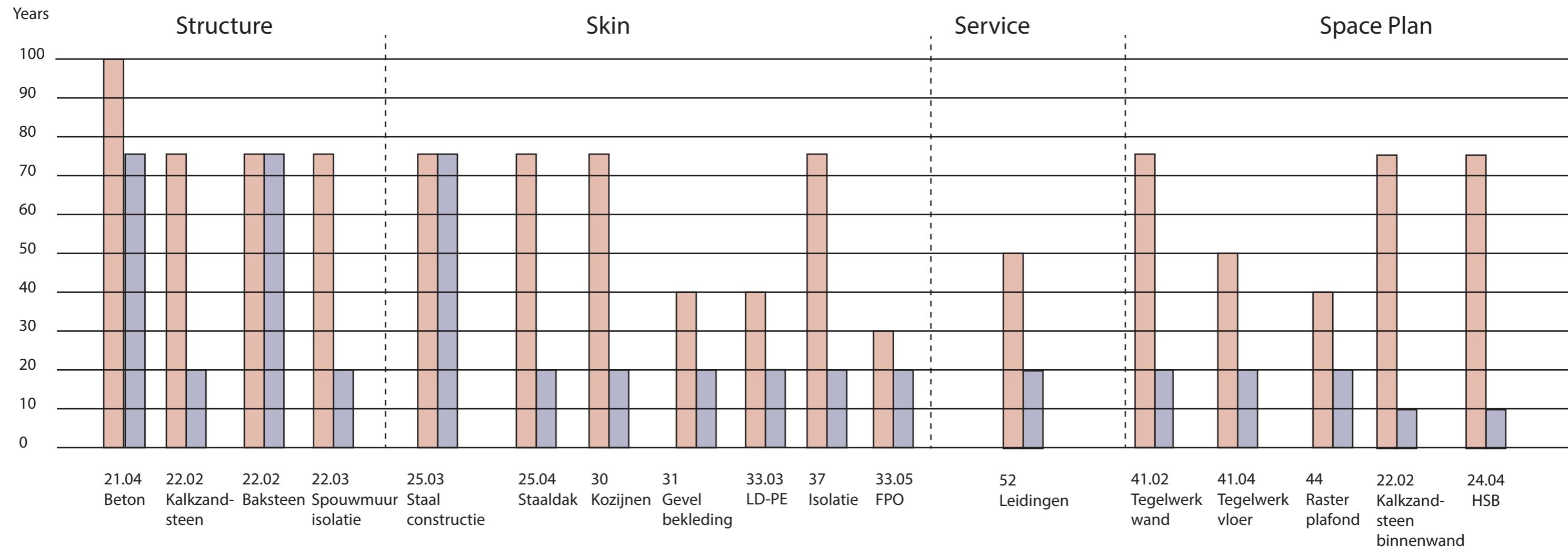
# Analysed materials

Step1: Calculate Virgin Feedstock		Step2: Calculate Unrecoverable Waste										Step3: Calculate Linear Flow Index						Step4: Calculate Utility Factor					Step4: Calculate MCI								
Specification Code	Material	M(x) (kg)	F <sub>R</sub>	F <sub>U</sub>	V (kg)	M(x) (kg)	C <sub>R</sub>	C <sub>U</sub>	W <sub>0</sub> (kg)	E <sub>R</sub>	W <sub>c</sub> (kg)	E <sub>F</sub>	F <sub>R</sub>	W <sub>r</sub> (kg)	W (kg)	M(x) (kg)	V	W	W <sub>F</sub>	W <sub>C</sub>	LFI	L	L <sub>AV</sub>	U	U <sub>AV</sub>	X	F	LFI	F	MCI* <sub>P</sub>	
14 02 Buitenriolering		10.8	0%	0	10.8	10.8	70%	0%	3.1968	100%	0	20%	0%	0	0	3.1968	10.8	10.8	3.1968	0	0	0.648	50	50	1	1	1	0.9	0.65	0.9	0.42
04 Hemelwaterafvoeren		3.5	60%	0	1.4	3.5	70%	29%	0.035	100%	0	100%	60%	0	0.035	3.5	1.4	0.035	0	0	0.205	20	30	1	1	0.666667	1.35	0.21	1.35	0.72	
20 02 Geprefabriceerd beton		17.246	20%	0	13.7968	17.246	99%	0%	0.103476	20%	13.65883	20%	0%	13.65883	13.76231	17.246	13.7968	13.76231	13.65883	13.65883	0.799	75	75	1	1	1	0.9	0.80	0.9	0.28	
03 Betonschroef boorpaal		22.834	20%	0	18.2672	22.834	99%	0%	0.137004	20%	18.08453	20%	0%	18.08453	18.22153	22.834	18.2672	18.22153	18.08453	18.08453	0.799	75	75	1	1	1	0.9	0.80	0.9	0.28	
21 04 Beton		425.9	20%	0	340.72	425.9	98%	0%	5.9626	20%	334.587	20%	20%	340.72	343.6161	425.9	340.72	343.6161	340.72	334.587	0.800518	75	75	1	1	1	0.9	0.80	0.9	0.28	
22 02 Kalkzandsteen		180	20%	0	144	180	92%	0%	15.12	20%	131.904	20%	20%	144	153.072	180	180	144	153.072	131.904	0.811566	8	75	1	1	0.106667	8.4375	0.81	8.4375	0.00	
02 Baksteen		180	0%	0	180	180	68%	0%	57.24	0%	122.76	100%	0%	122.76	180	180	180	122.76	122.76	1	20	75	1	1	0.266667	3.375	1.00	3.375	0.00		
03 Spouwmuur isolatie		3.3	0%	0	3.3	3.3	6%	0%	3.1053	0%	0.1947	100%	0%	0.1947	3.3	3.3	3.3	3.3	0.1947	1	20	75	1	1	0.266667	3.375	1.00	3.375	0.00		
24 01.04. Plywood		31.5	0%	0	31.5	31.5	6%	0%	29.547	0%	1.953	100%	0%	1.953	31.5	31.5	31.5	1.953	1.953	1	20	75	1	1	0.266667	3.375	1.00	3.375	0.00		
04 HSB elementen		31.5	0%	0	31.5	31.5	6%	0%	29.547	0%	1.953	200%	0%	1.953	31.5	31.5	31.5	1.953	1.953	1	20	75	1	1	0.266667	3.375	1.00	3.375	0.00		
25 02 Staalconstructiewerk		60	60%	0	24	60	51%	49%	0	100%	0	100%	60%	0	0	60	24	0	0	0	0	0.2	75	75	1	1	1	0.9	0.20	0.9	0.82
04 Staaldak		6.9	60%	0	2.76	6.9	70%	29%	0.069	100%	0	100%	60%	0	0.069	6.9	2.76	0.069	0	0	0.205	20	75	1	1	0.266667	3.375	0.21	3.375	0.31	
30 04 Houten Kozijn		2.8	0%	0	2.8	2.8	0%	0%	2.7944	0%	0.0056	100%	0%	0.0056	2.8	2.8	2.8	0.0056	0.0056	1	20	75	1	1	0.266667	3.375	1.00	3.375	0.00		
05 Stalen Kozijn		3.1	37%	0	1.953	3.1	93%	0%	0.2139	100%	0	100%	37%	0	0.2139	3.1	1.953	0.2139	0	0	0.3495	20	75	1	1	0.266667	3.375	0.35	3.375	0.00	
05 Aluminium Kozijn		3.8	30%	0	2.66	3.8	63%	0%	1.406	100%	0	100%	30%	0	1.406	3.8	2.66	1.406	0	0	0.535	20	75	1	1	0.266667	3.375	0.54	3.375	0.00	
06 Houten Deur Paneelspaan		21.3	0%	0	21.3	21.3	0%	0%	21.3	0%	0	100%	0%	0	21.3	21.3	21.3	0	0	1	20	75	1	1	0.266667	3.375	1.00	3.375	0.00		
06 Houten Deur Volspaan		21.3	0%	0	21.3	21.3	4%	0%	20.4267	0%	0.8733	100%	0%	0.8733	21.3	21.3	21.3	0.8733	0.8733	1	20	50	1	1	0.4	2.25	1.00	2.25	0.00		
07 Panelen Sandwich		15.75	0%	0	15.75	15.75	47%	20%	5.229	100%	0	100%	0%	0	5.229	15.75	15.75	5.229	0	0	0.666	20	50	1	1	0.4	2.25	0.67	2.25	0.00	
10 Vliesgevelsysteem		13.63	30%	0	9.541	13.63	77%	10%	1.7719	100%	0	100%	30%	0	1.7719	13.63	9.541	1.7719	0	0	0.415	20	100	1	1	0.2	4.5	0.42	4.5	0.00	
31 03 Alucobond		6.3	47%	0	3.339	6.3	80%	0%	1.26	100%	0	100%	47%	0	1.26	6.3	3.339	1.26	0	0	0.365	20	40	1	1	0.5	1.8	0.37	1.8	0.34	
04 Lamellen bekleding		22.6	49%	0	11.526	22.6	87%	6%	1.6272	100%	0	100%	49%	0	1.6272	22.6	11.526	1.6272	0	0	0.291	20	25	1	1	0.8	1.125	0.29	1.125	0.67	
05 Sandwich paneel		12.7	15%	0	10.795	12.7	47%	20%	4.2164	90%	0.59944	100%	15%	0.59944	4.81584	12.7	10.795	4.81584	0.59944	0.59944	0.6146	20	40	1	1	0.5	1.8	0.61	1.8	0.00	
33 33.03 Sarnavap 1000 PE-LD		0.2	0%	0	0.2	0.2	5%	0%	0.19	100%	0	100%	0%	0	0.19	0.2	0.2	0.19	0	0	0.975	20	40	1	1	0.5	1.8	0.98	1.8	0.00	
04 Dak isolatie		4.8	0%	0	4.8	4.8	4%	0%	4.6032	100%	0	100%	0%	0	4.6032	4.8	4.8	4.6032	0	0	0.9795	20	75	1	1	0.266667	3.375	0.98	3.375	0.00	
05 FPO Dakbedekking NIBE		3.2	0%	0	3.2	3.2	6%	0%	2.9888	100%	0	100%	0%	0	2.9888	3.2	3.2	2.9888	0	0	0.967	20	30	1	1	0.666667	1.35	0.97	1.35	0.00	
05 FPO Dakbedekking 85%		3.2																													

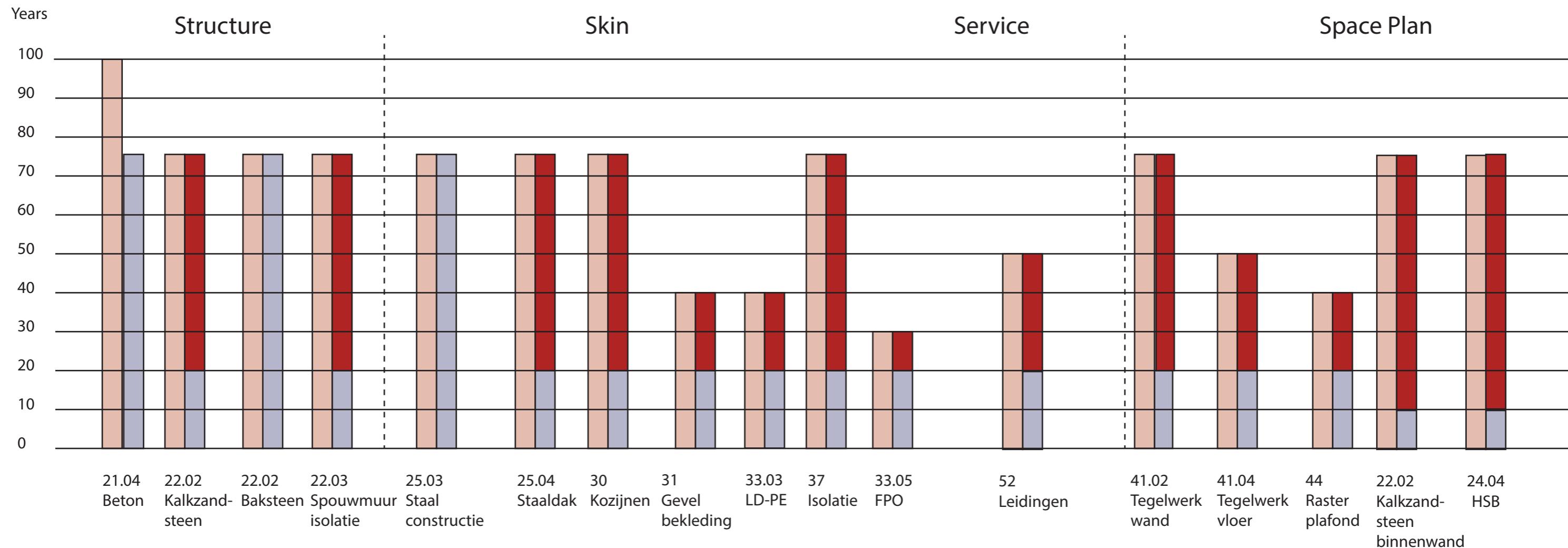
# Technical life span



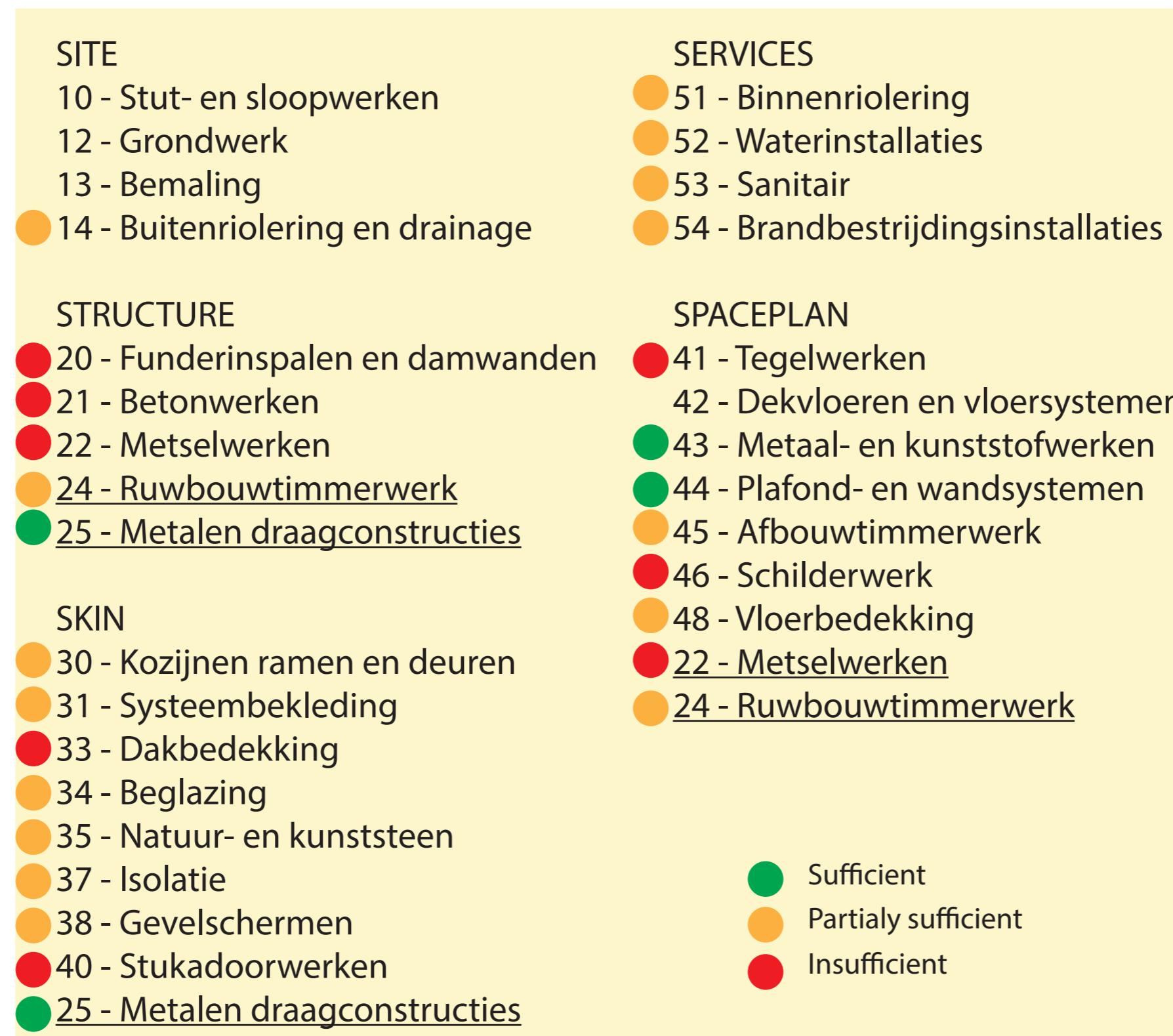
# Functional life span



# Value left



# Specification Analysis



# Redesigns

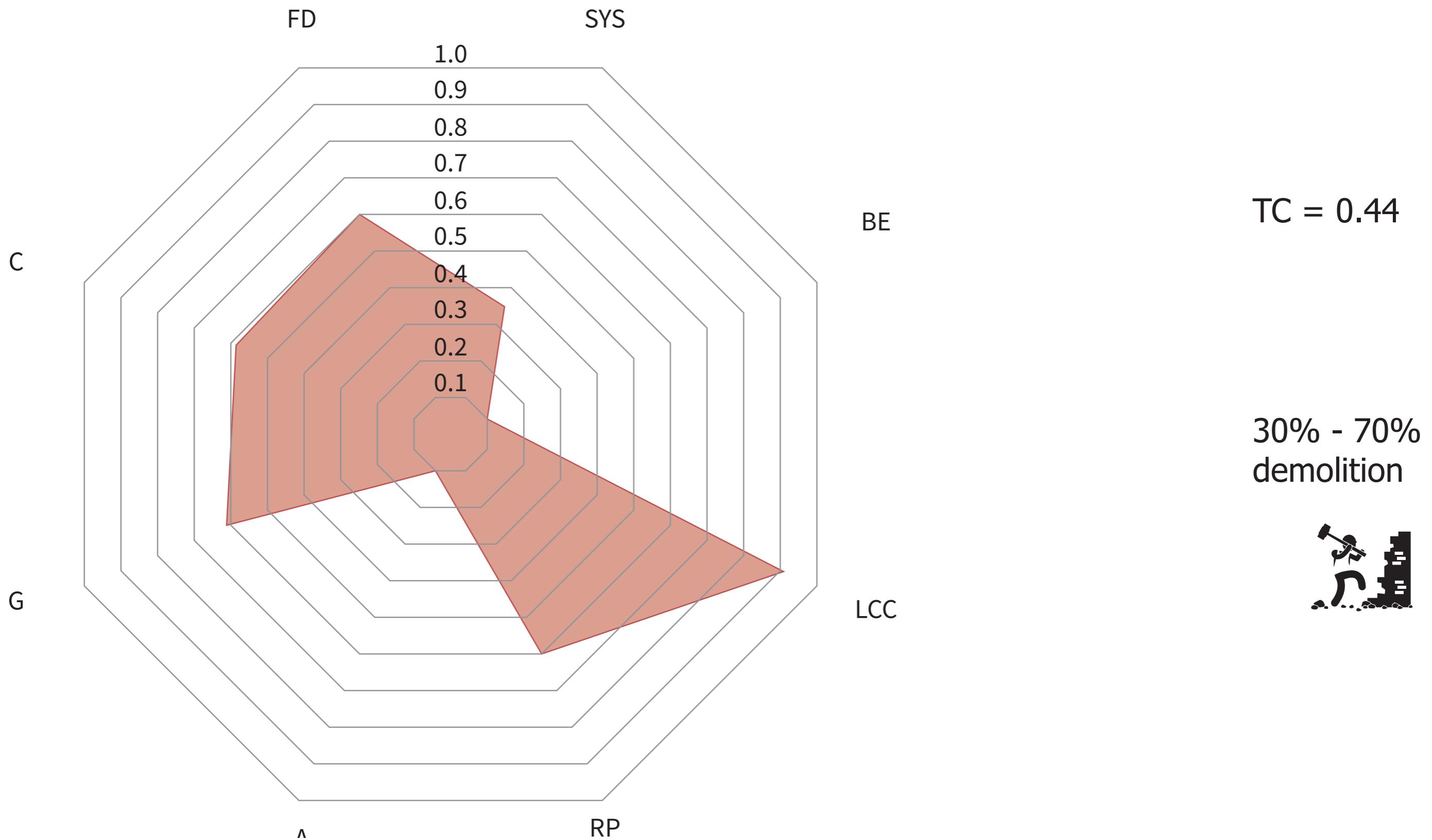
How can a building system, as described in the Specification, be redesigned into a circular one?

# Roof original

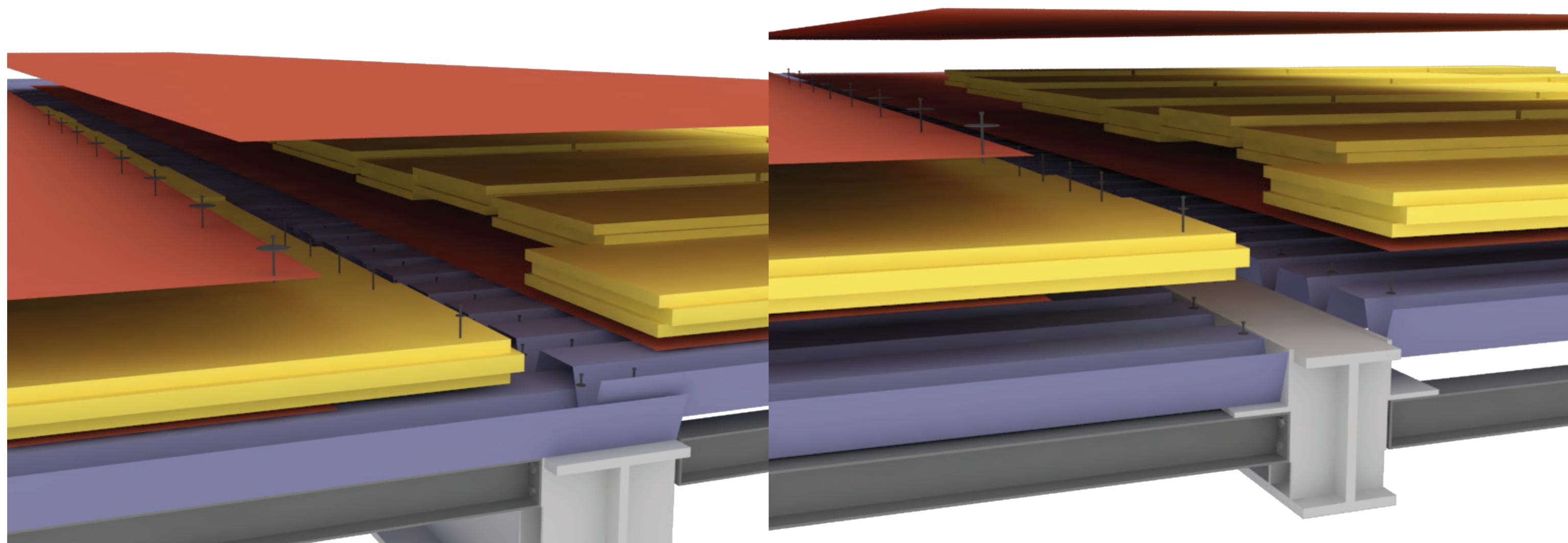


# Roof original

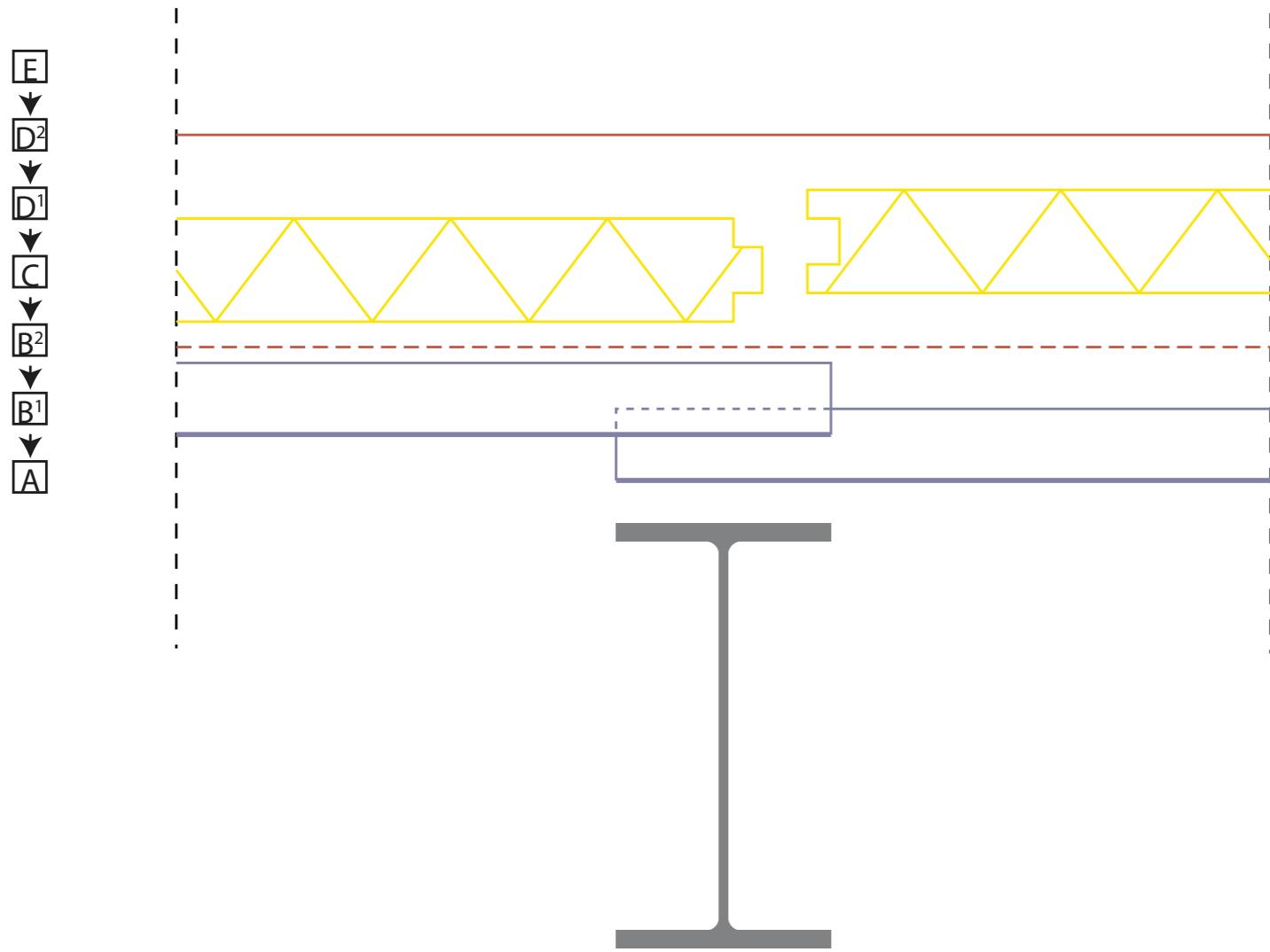
## Disassembly Potential



# Assembly (A)

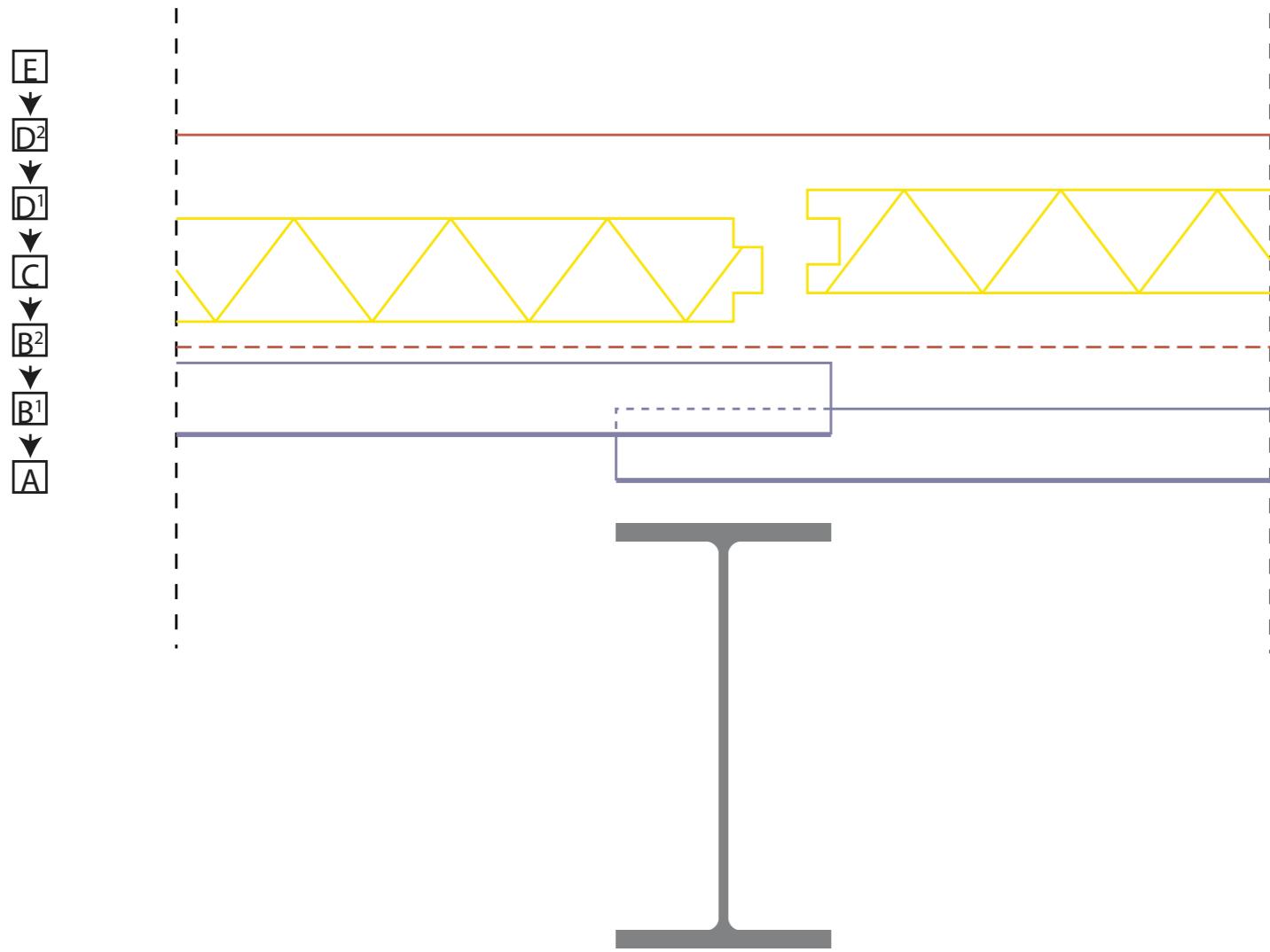


# Assembly (A)



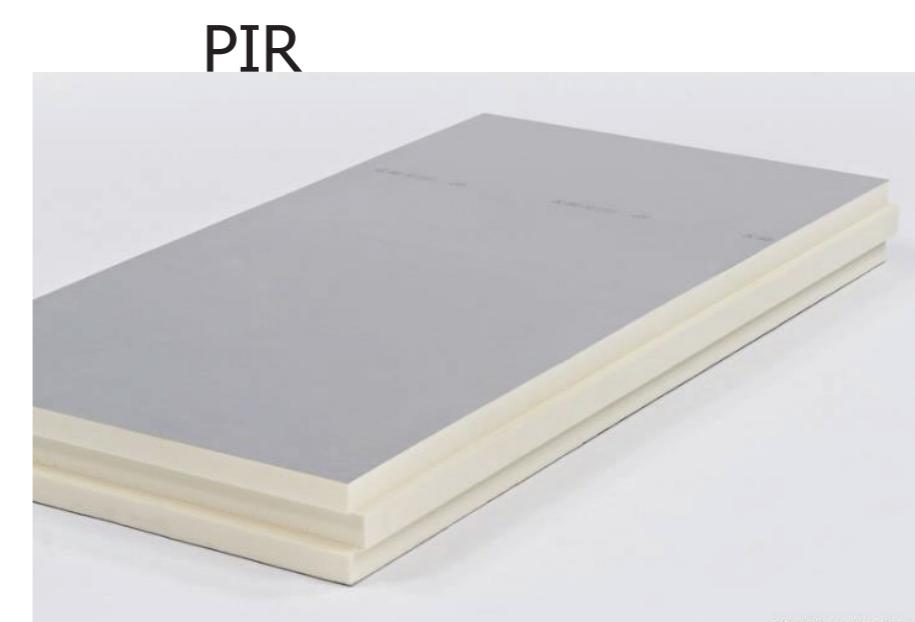
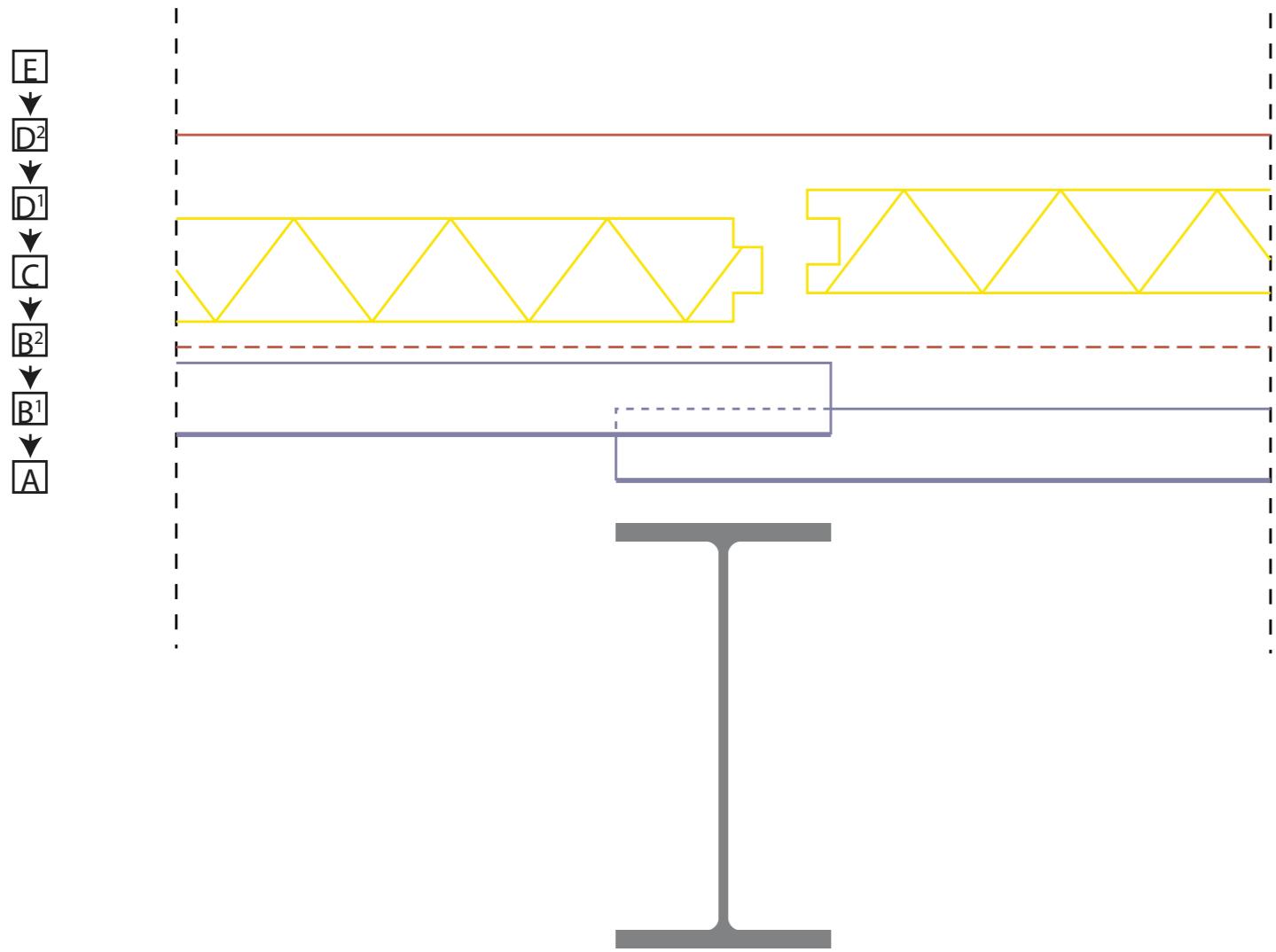
Corrugated steel

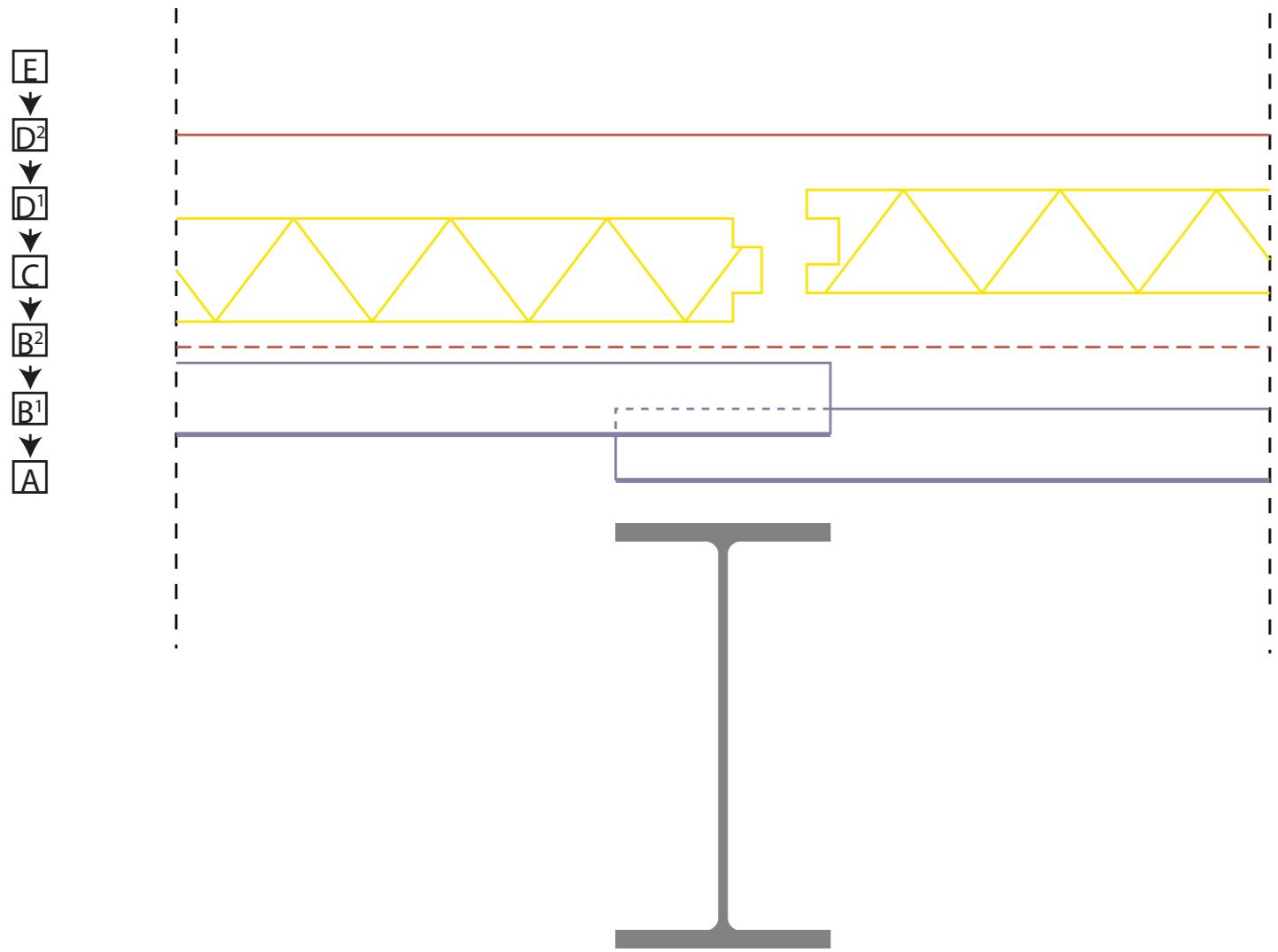




LD-PE Vapour







FPOBarrier



# Material Circularity

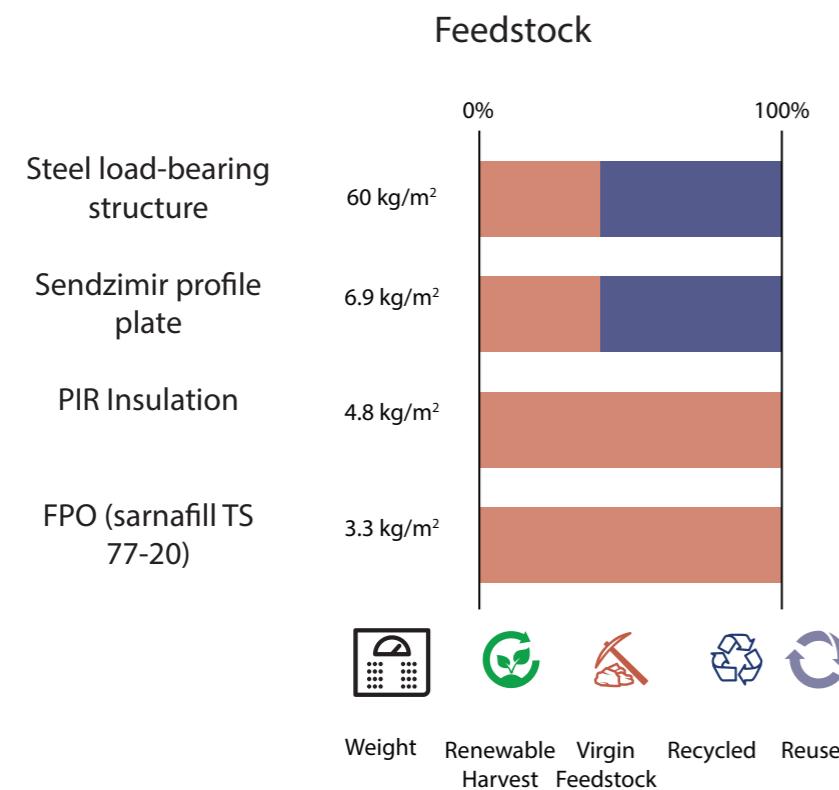
Steel load-bearing  
structure

Sendzimir profile  
plate

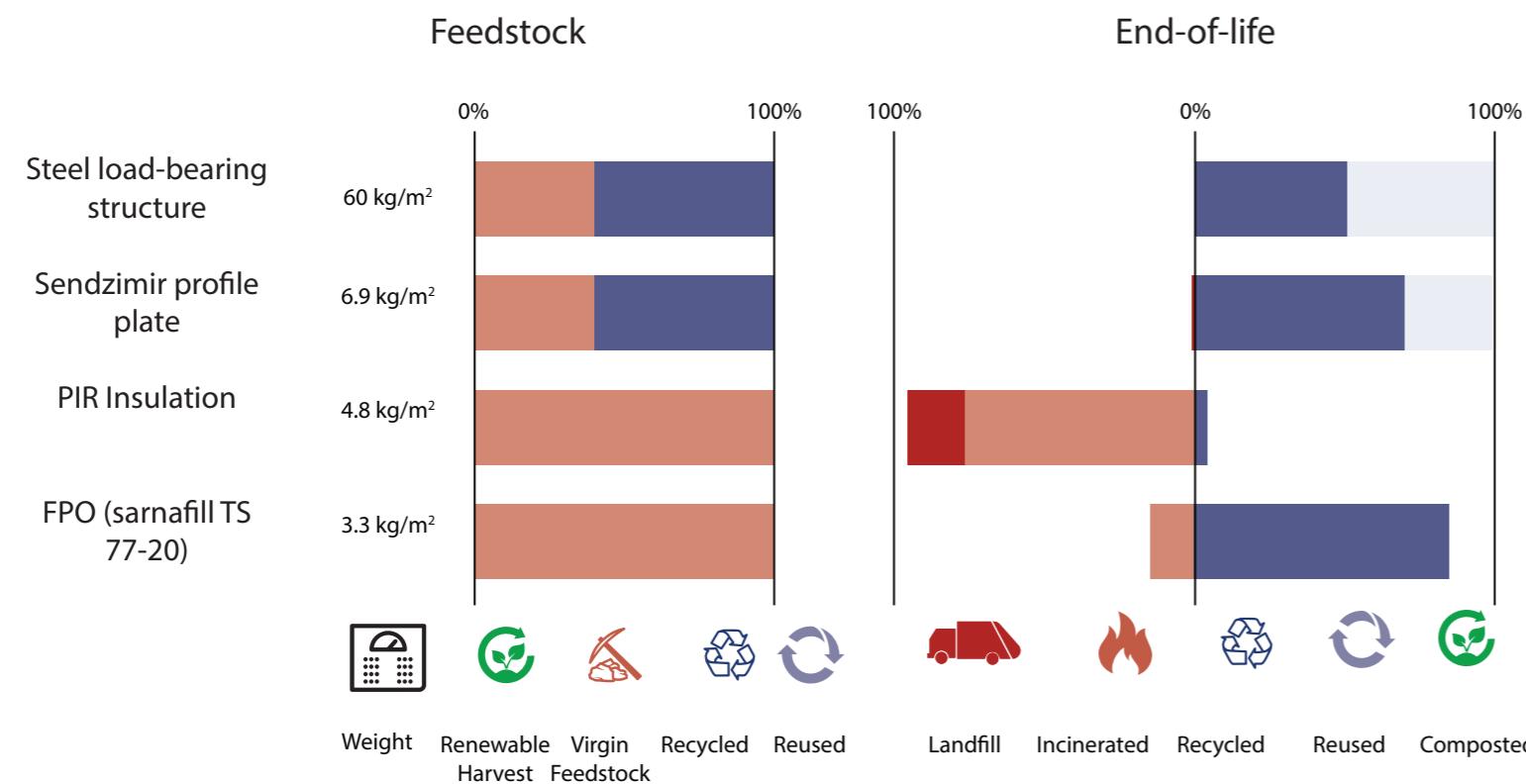
PIR Insulation

FPO (sarnafil TS  
77-20)

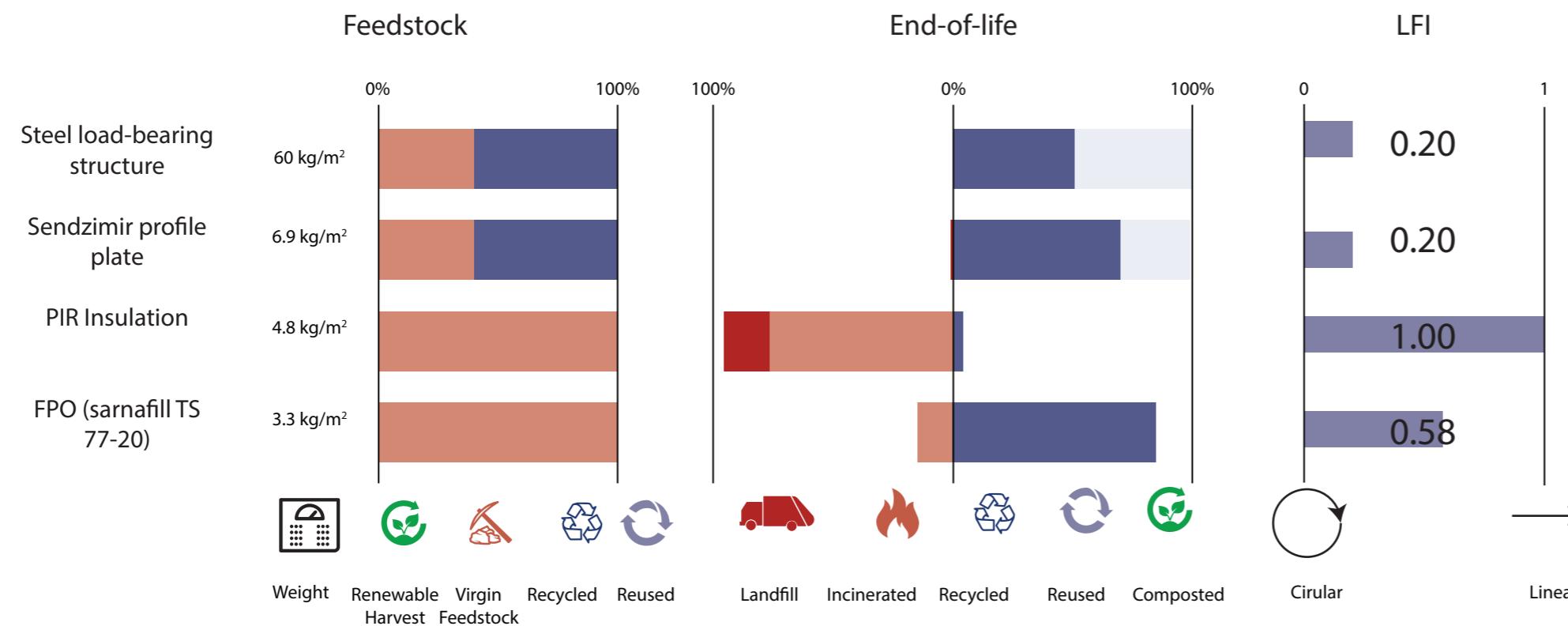
# Material Circularity



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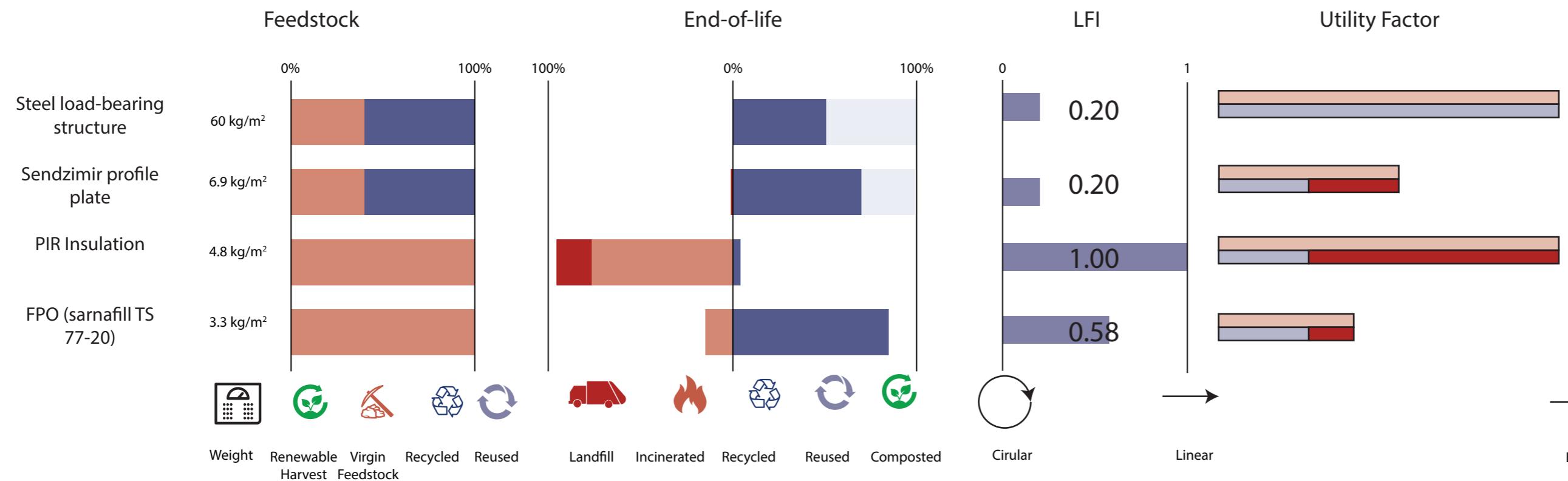
Structure and roof MCI

Total LFI = 0.25

Roof only MCI

Total LFI = 0.54

# Material Circularity



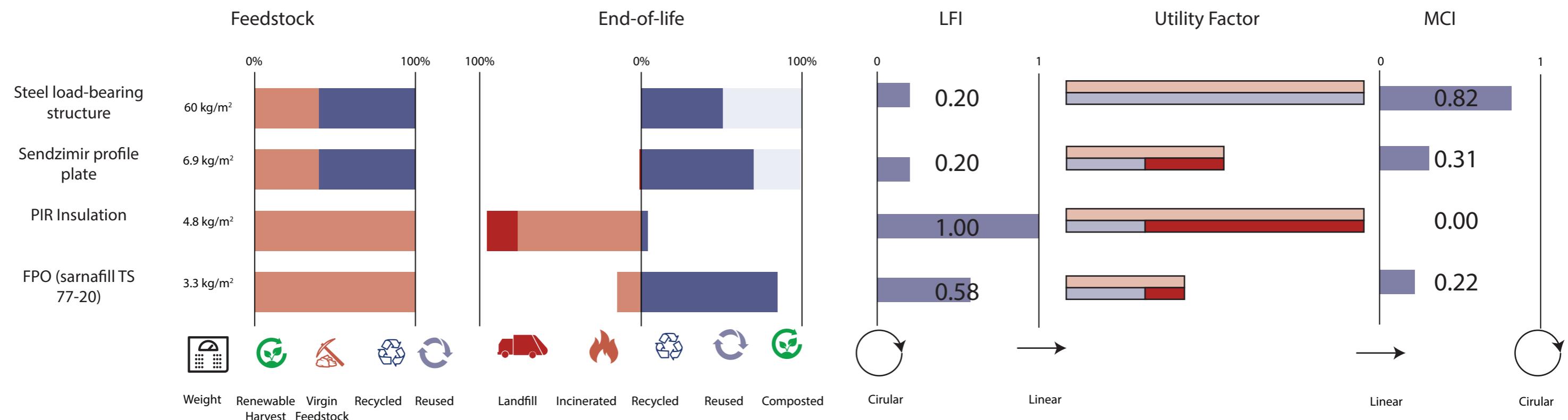
Structure and roof MCI

Total LFI = 0.25

Roof only MCI

Total LFI = 0.54

# Material Circularity



Structure and roof MCI

Total LFI = 0.25

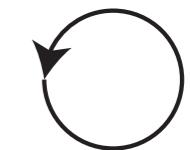
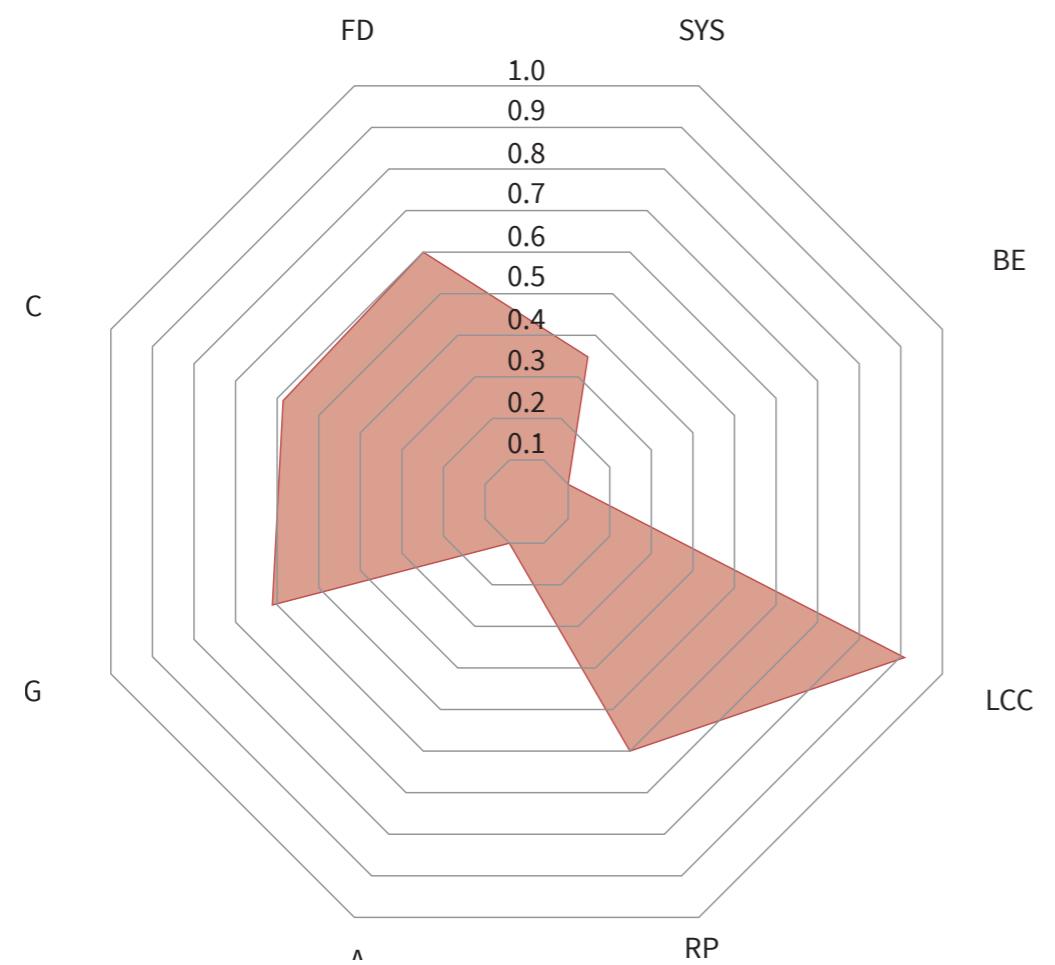
Total MCI = 0.69

Roof only MCI

Total LFI = 0.54

Total MCI = 0.19

# What did we learn?

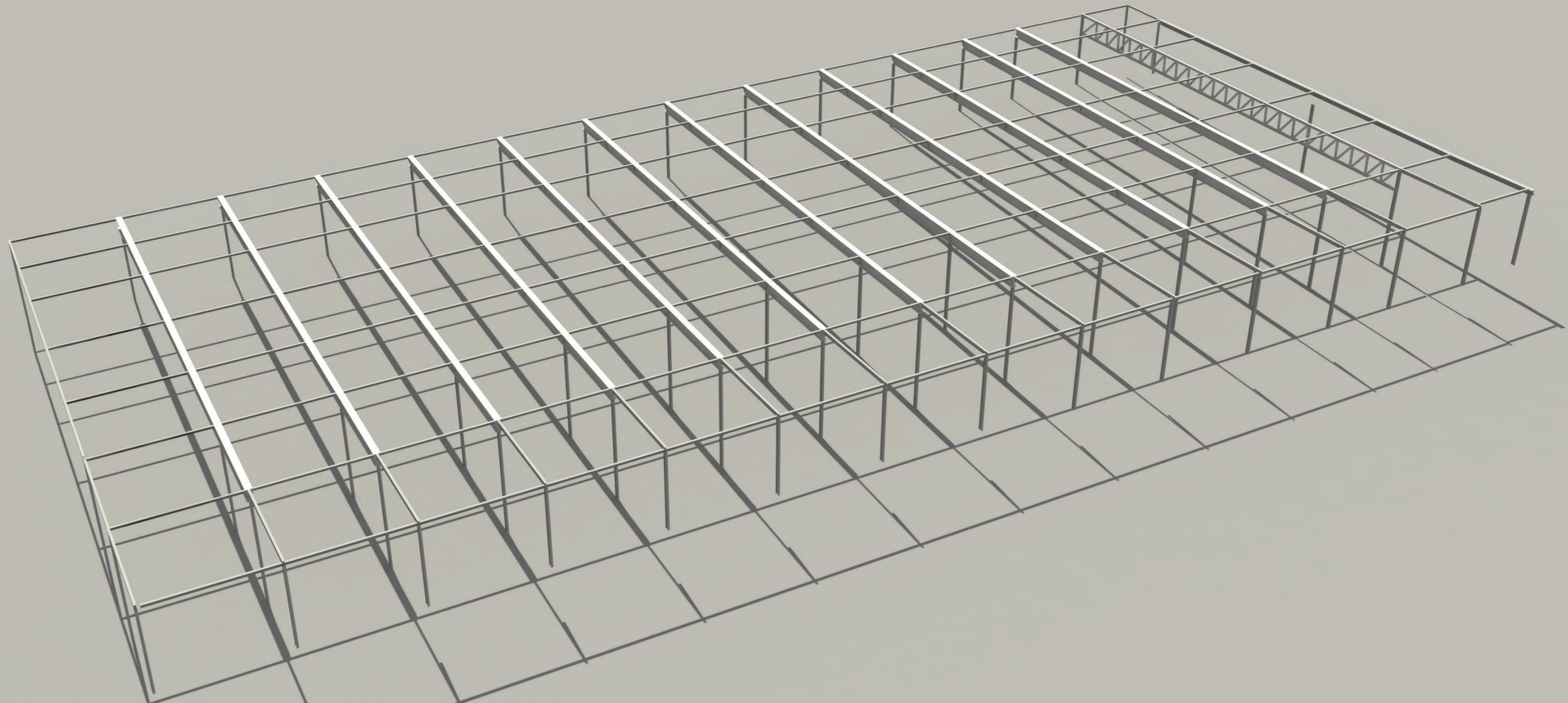


# Redesigns

## Green



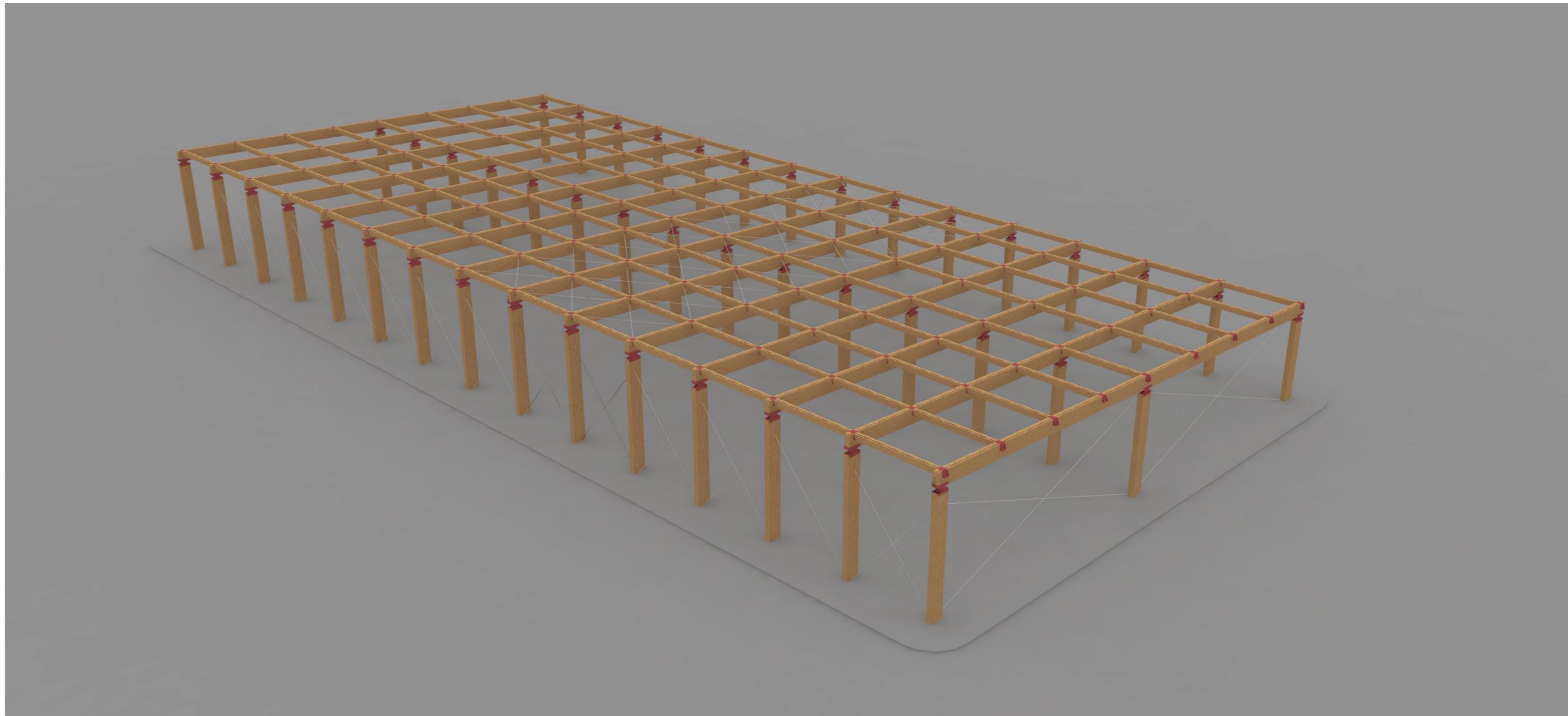
# Technical



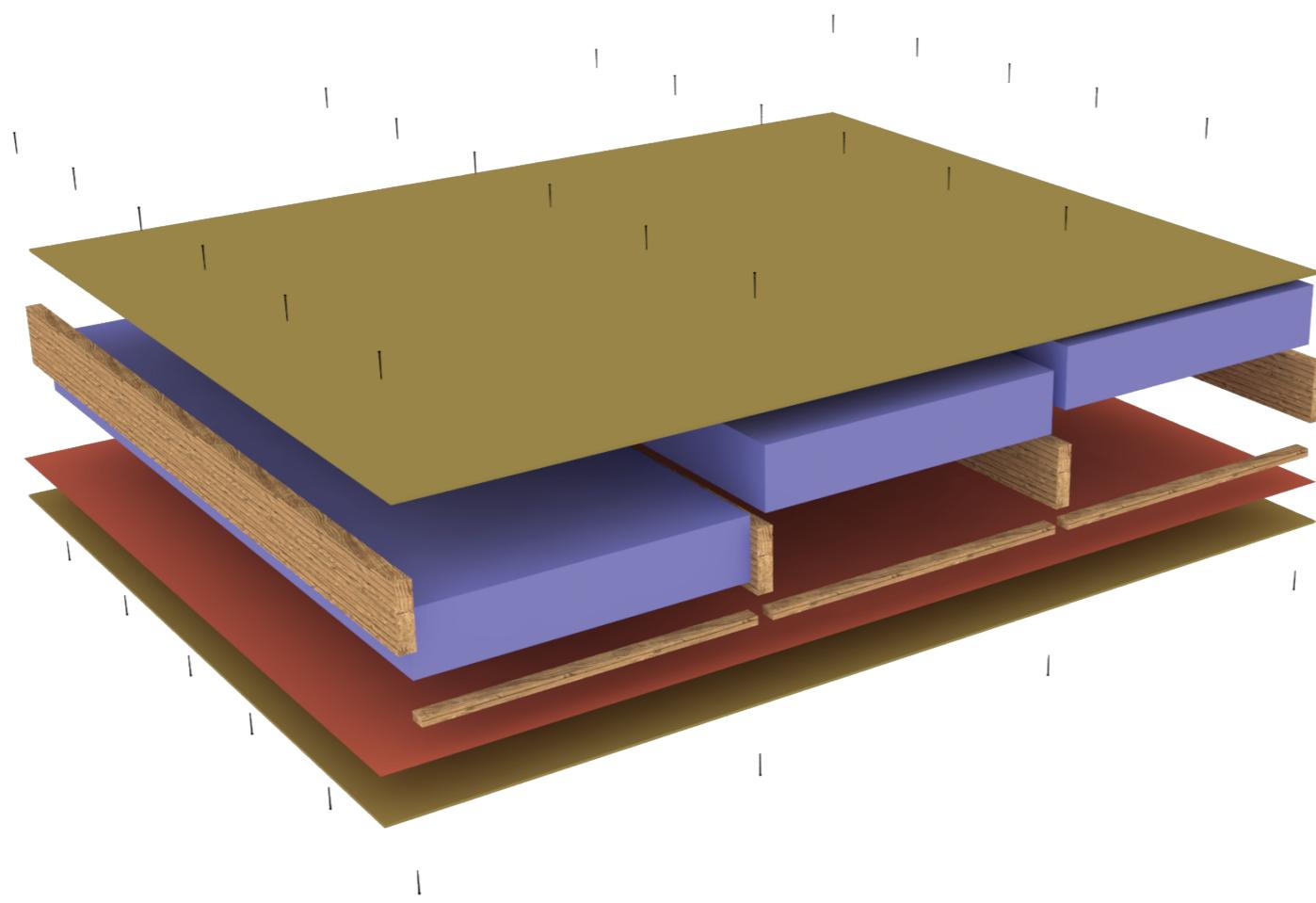
# Green Redesign



# Load-bearing Structure



# Sandwich panel System



Accoya Gluelam



Metisse



ECOBoard

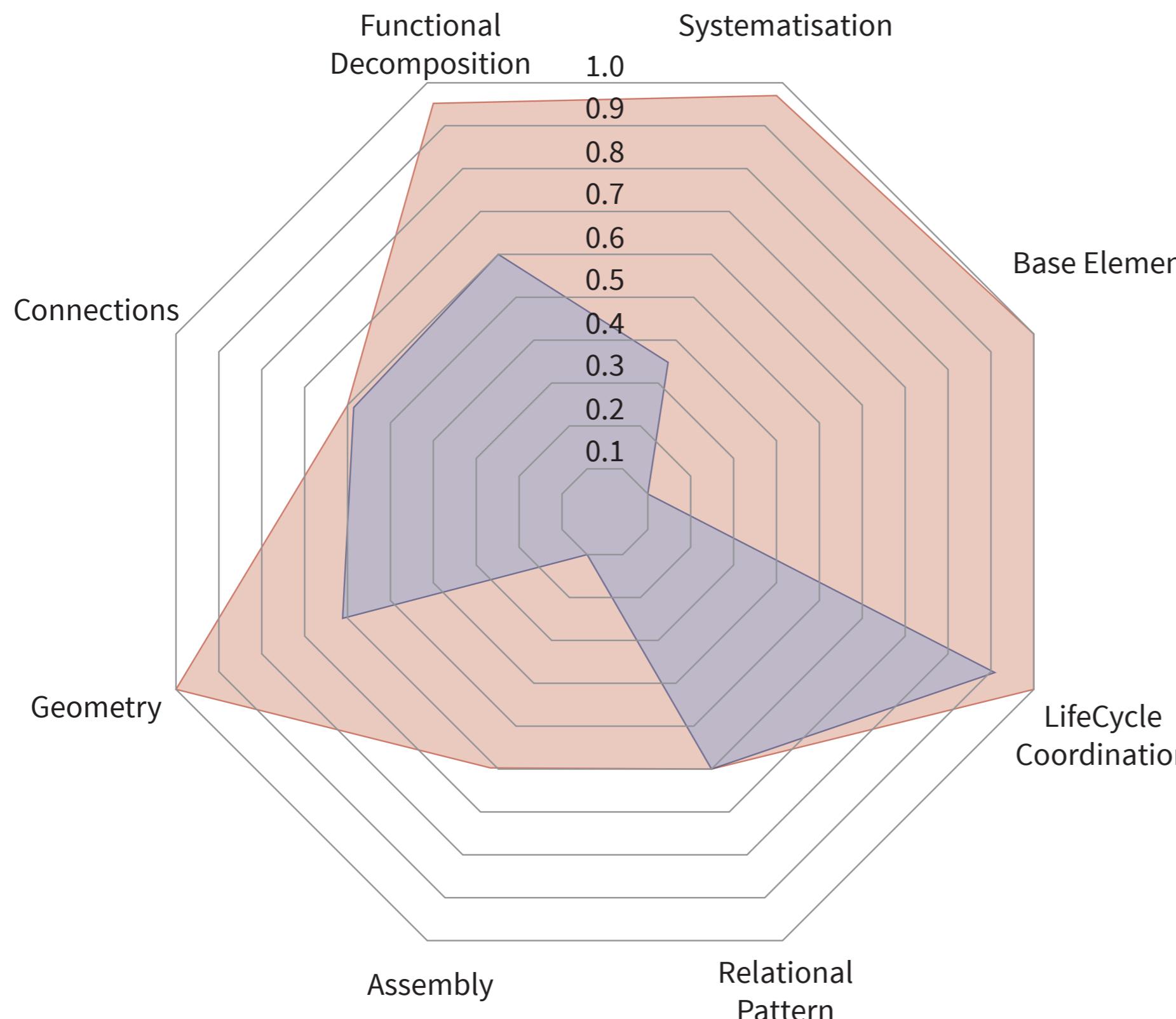


Derbipure



# Green Redesign

## Disassembly Potential

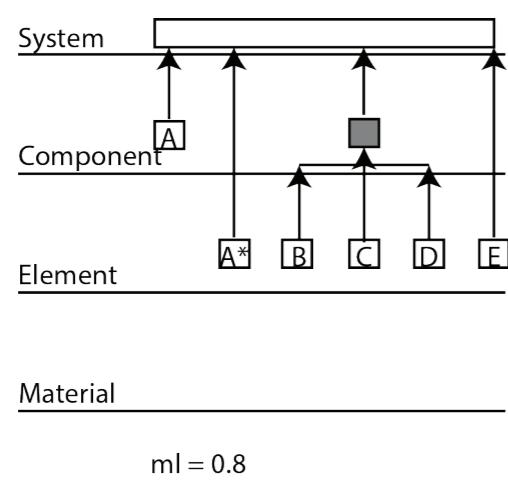


$TC = 0.81$

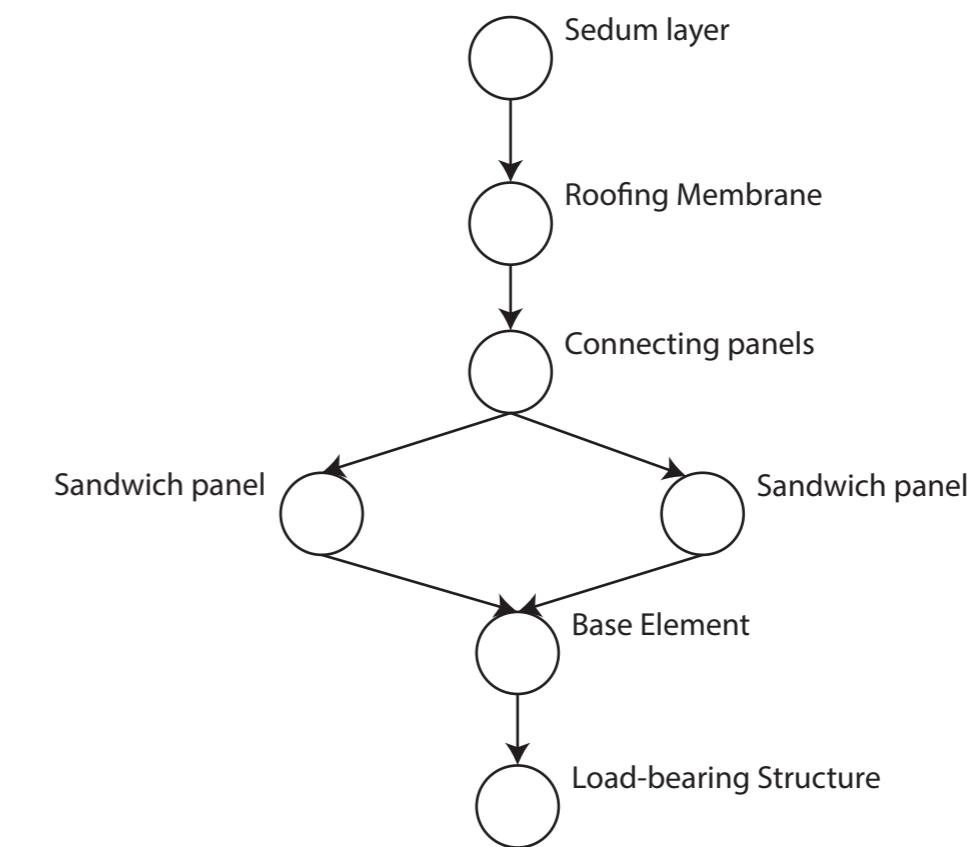
0% - 30% demolition



# Green Redesign

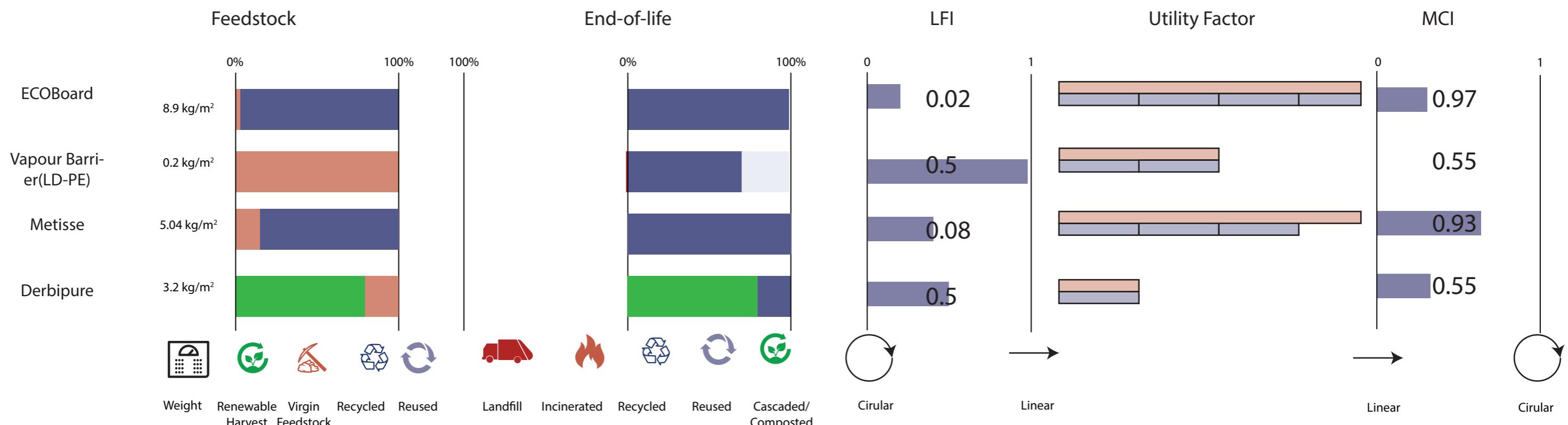

 $m_l = 0.8$ 

Clustering to functionality  
 $c = 1$



# Green redesign

## Material Circularity



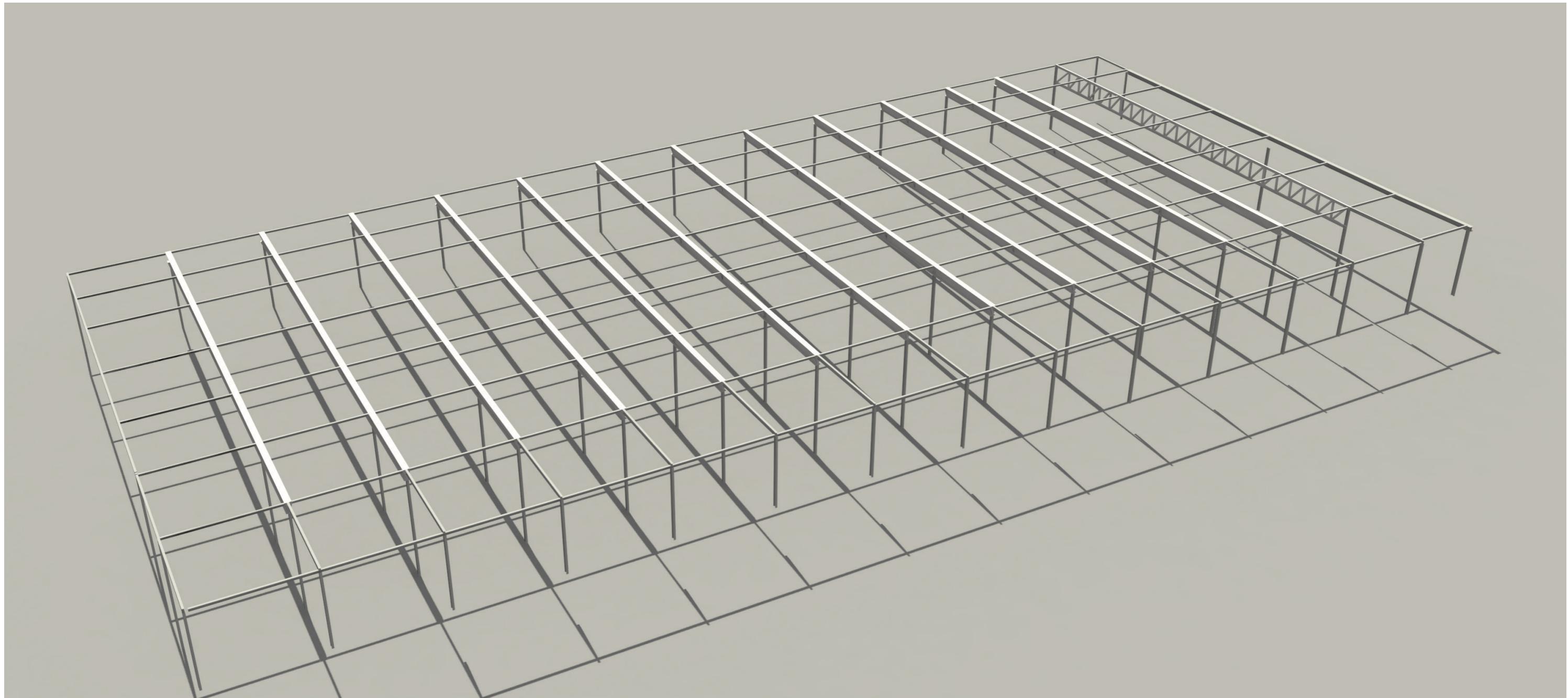
### Green redesign MCI

Total LFI = 0.37

Total MCI = 0.52

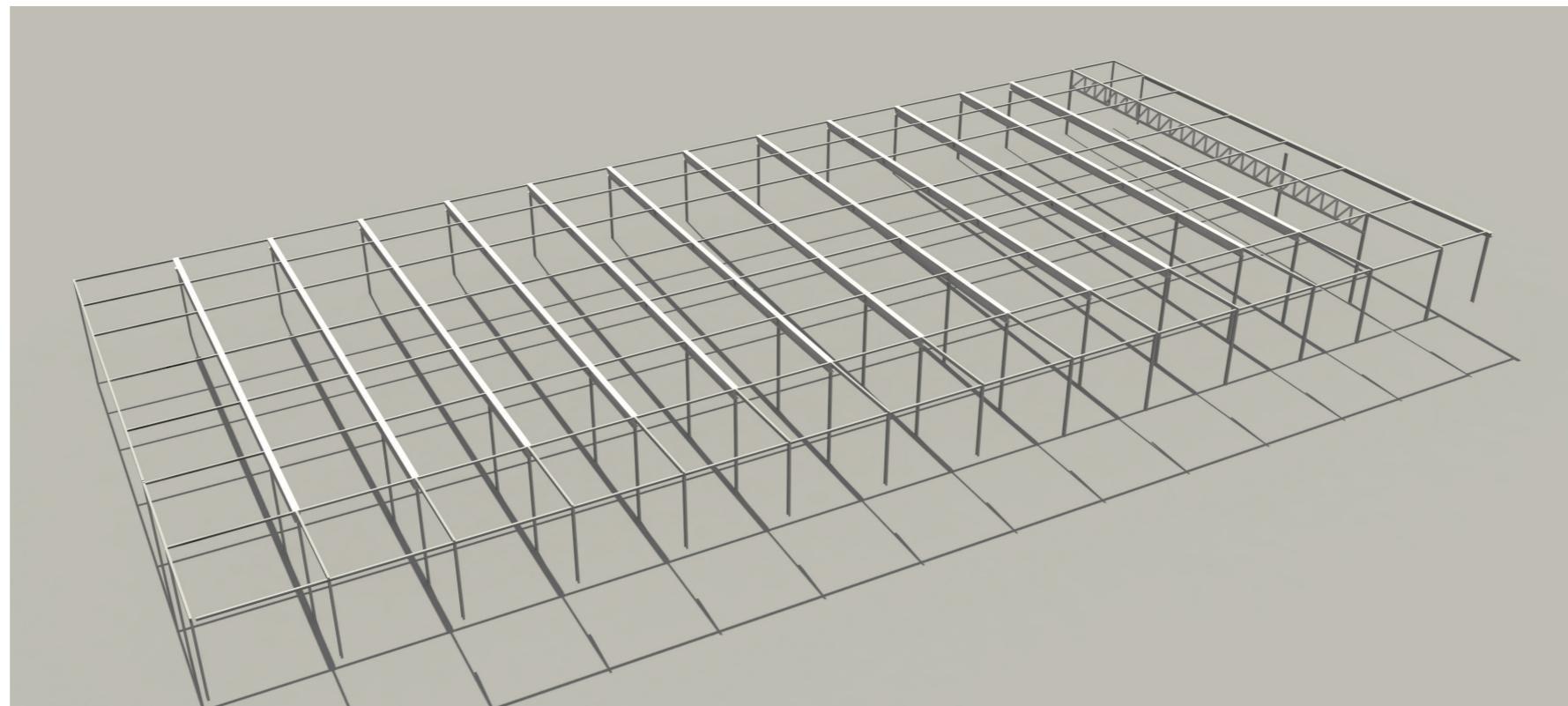
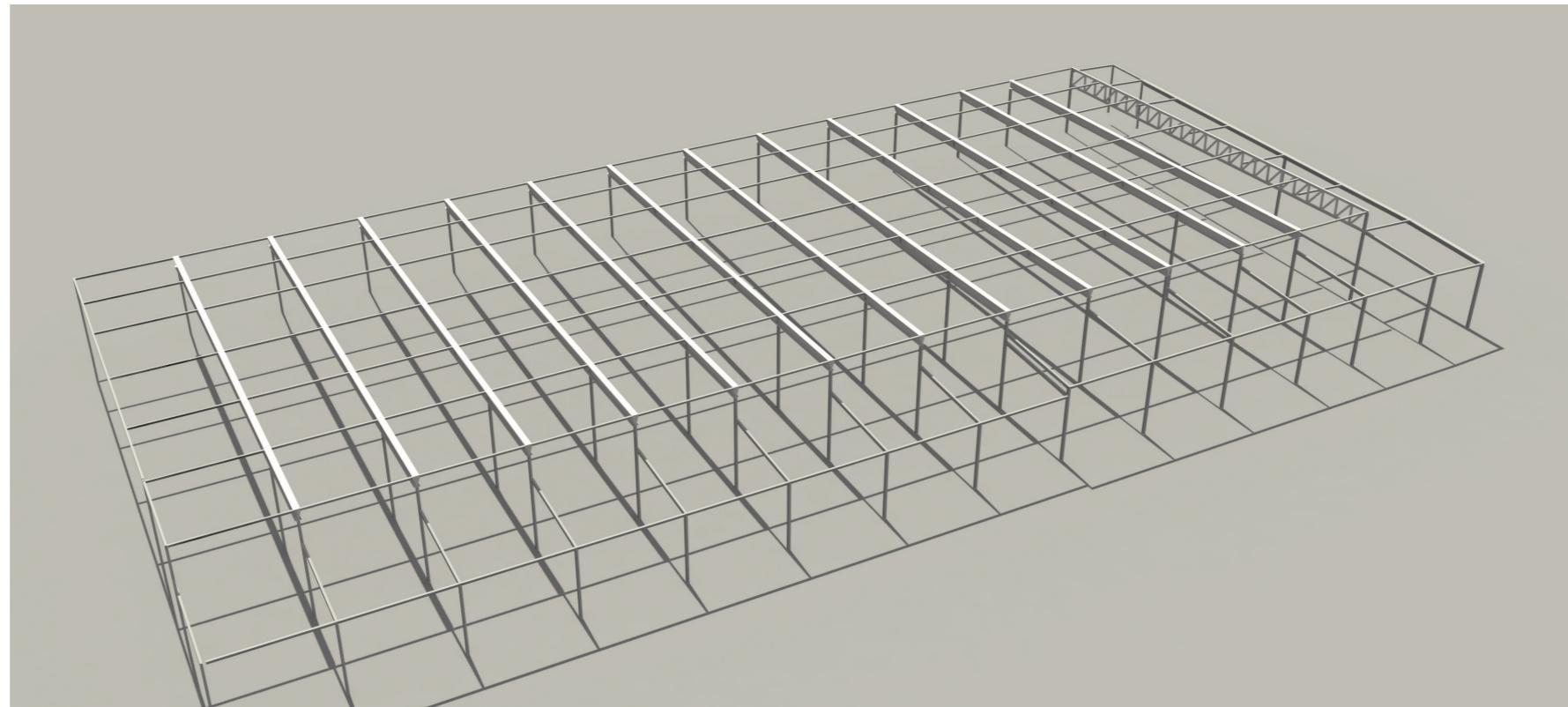
# Technical Redesign

## Technical



# Technical Redesign

Make it generic



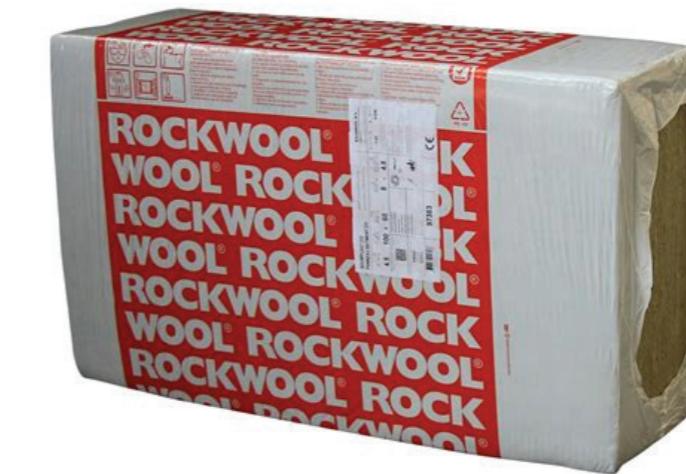
# Technical Redesign

Original



PIR

Recyclable



Rockwool



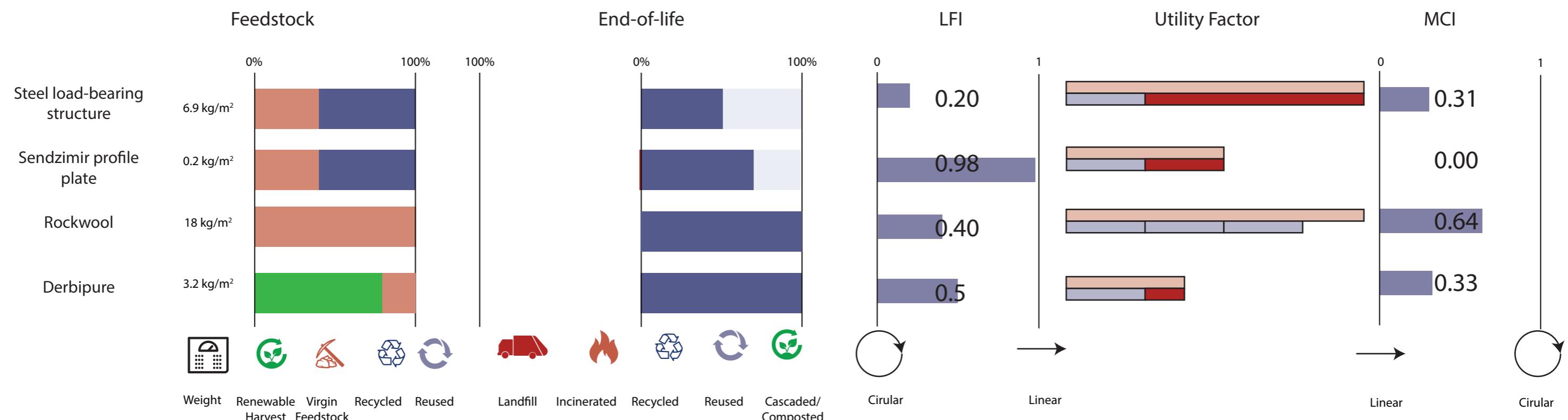
(FPO) Sarnafil 77 - 20



Derbipure

# Technical Redesign

## Material Circularity

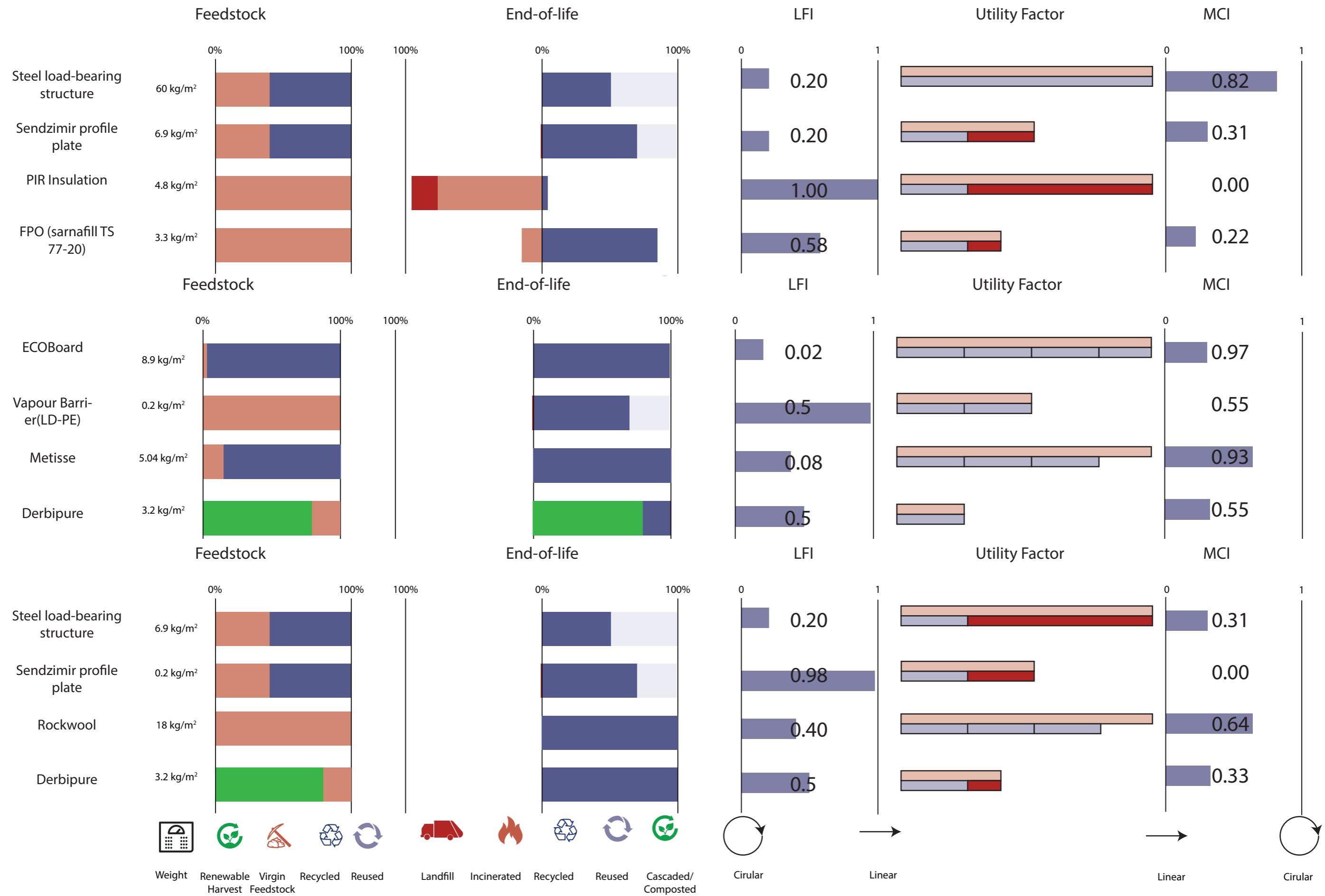


### Technical redesign MCI

Total LFI = 0.37

Total MCI = 0.52

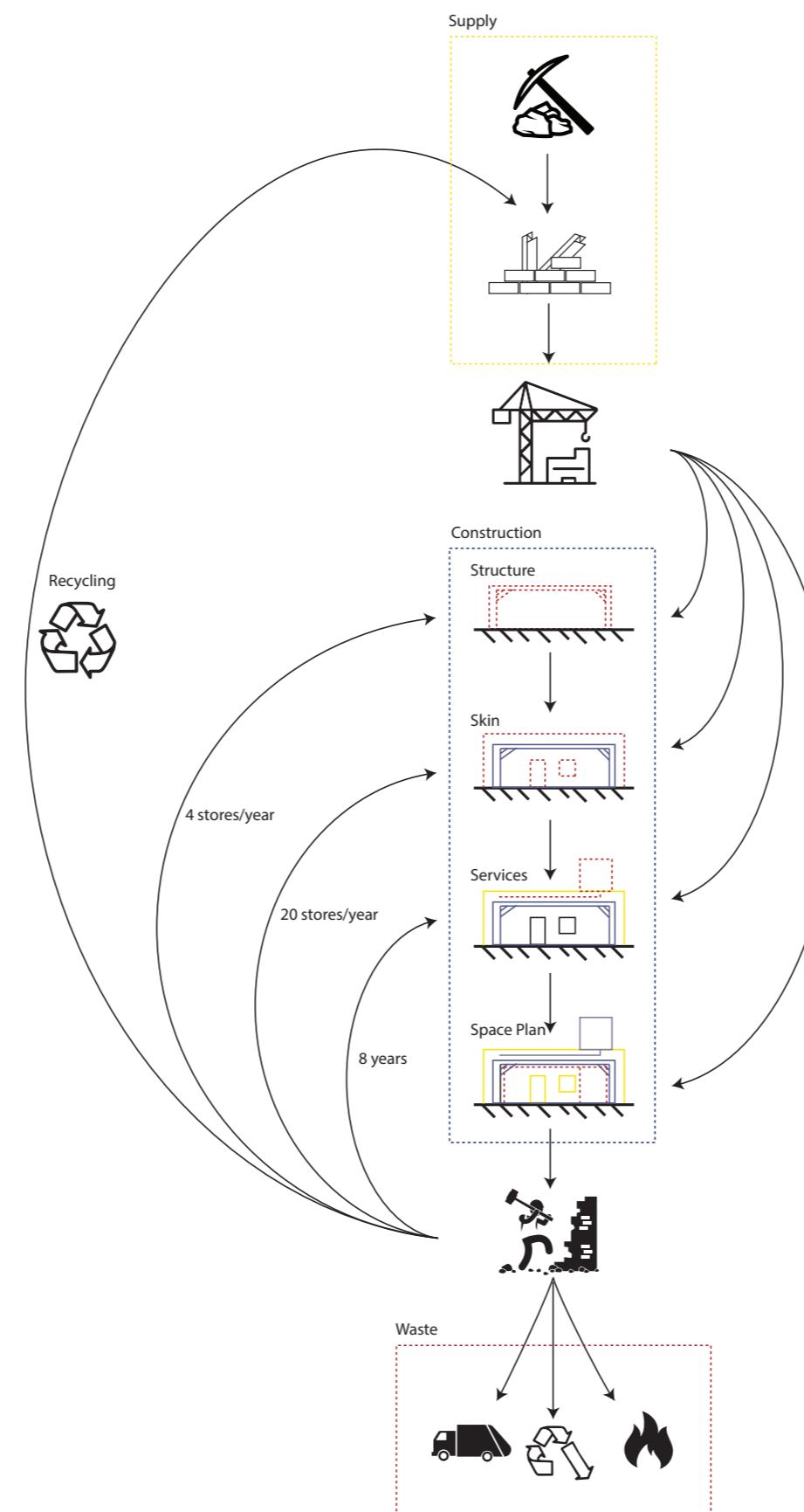
# Comparison



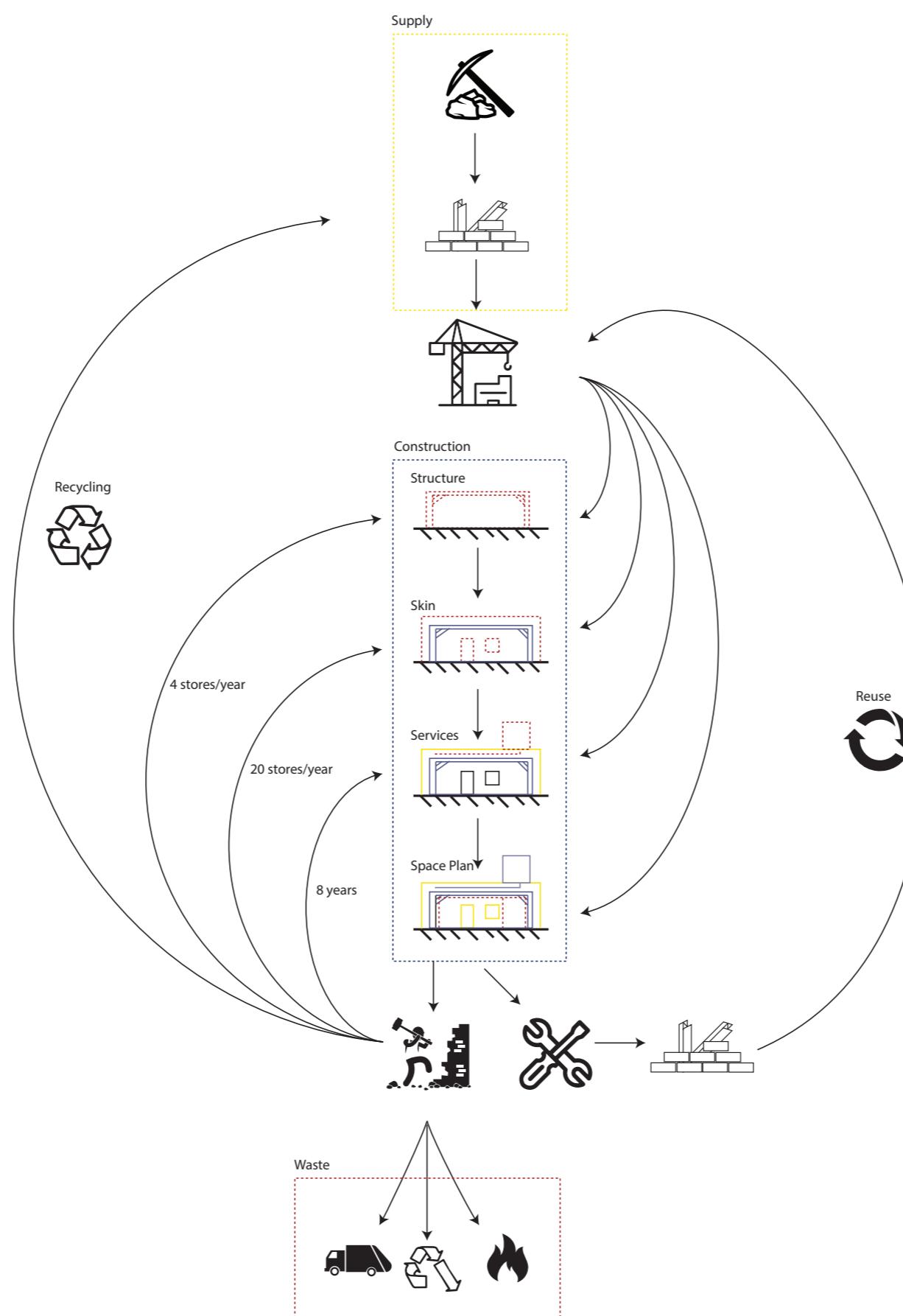
# Reimplementation

Which changes have to be made to make the Lidl's Specification circular, with an emphasis on materials and assembly?

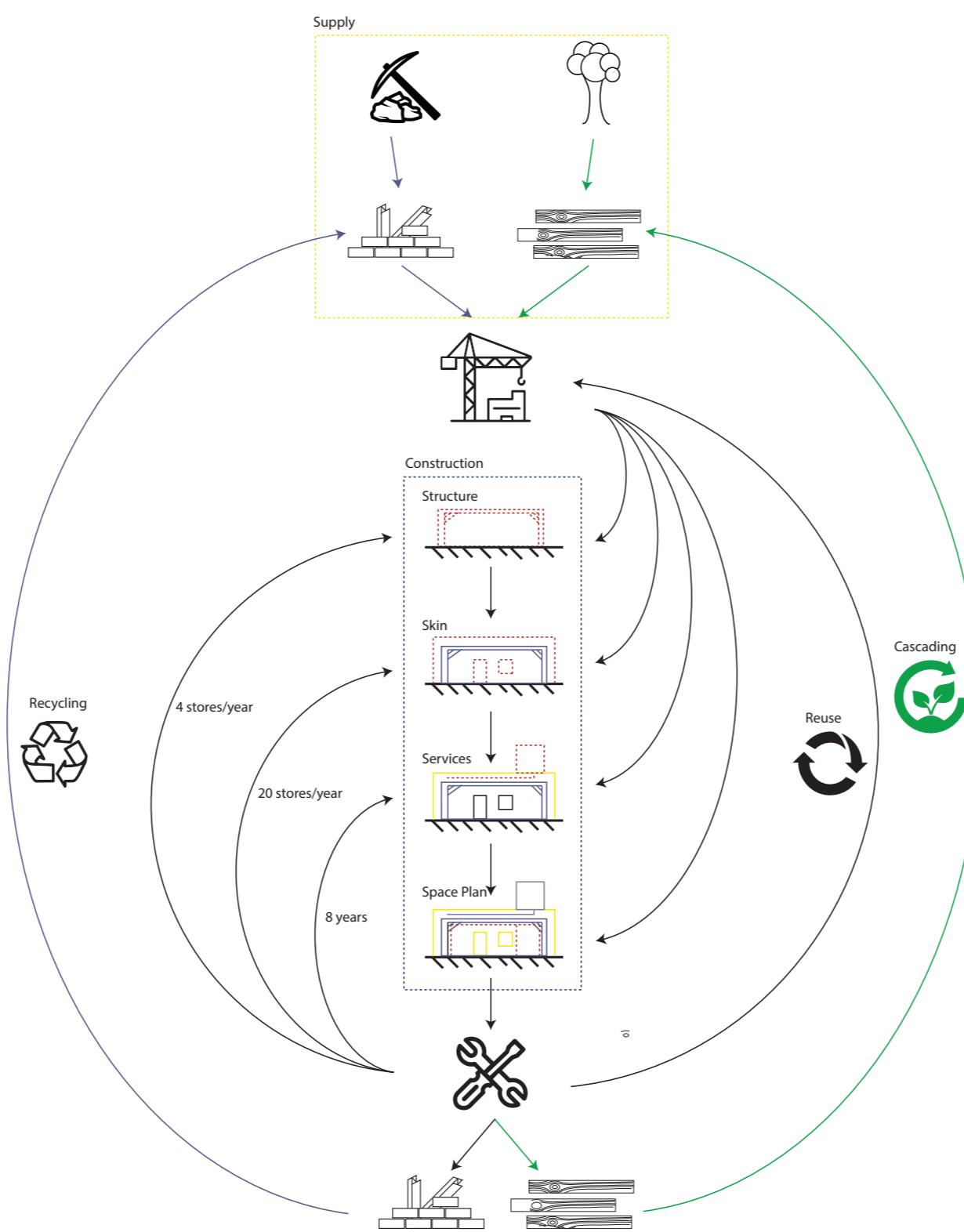
# Development strategy -linear



# Development strategy - reuse

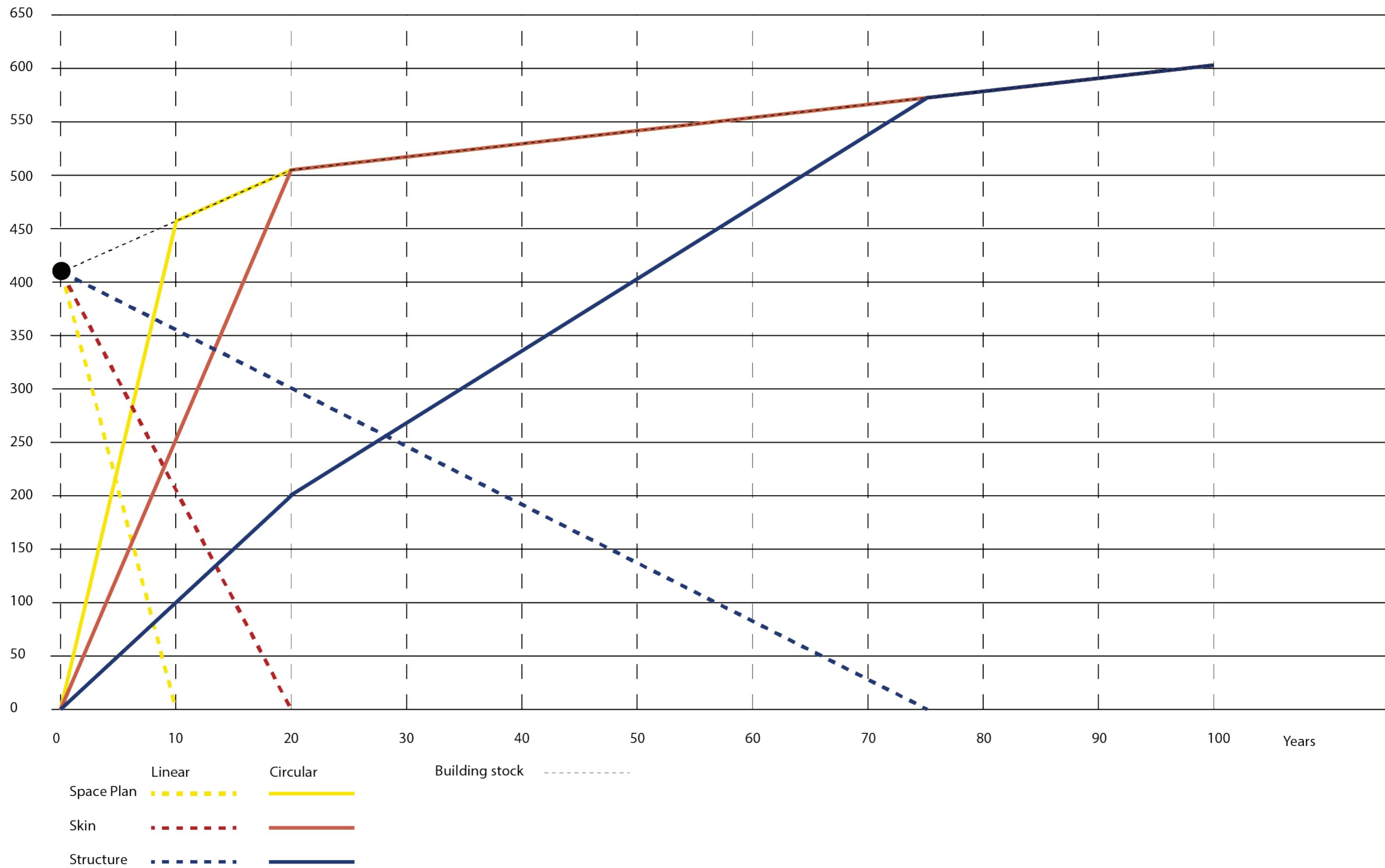


# Development strategy - fully circular



# Future

Amount of Stores



# Changes

- Non-circular materials to circular materials, which can be economically- recycled or are renewable.
- Enable reuse, remove static construction methods make all connections reversible.
- Make dimensions and connections generic
- Implement criteria from the Circularity Indicator to the Specification.
- Change the development strategy, reuse elements and components which are still performing at their technical

# Recommendation further research

## A full circular Assessment method

- Inclusion of emissions and the biological cycle

## Recycling Efficiency

- Economical recycling processes, which are there, how often employed?

## Economic viability

- How much value is actually saved, when will there be a return on investment?

## Lidl from construction waste

- - How long will it take before we can build a Lidl supermarket out of demolition and renovation waste?

## Supermarket in the Biological cycle

- The current design is fully in the technological cycle, I propose a step for the roof and load-bearing structure. How far can we actually get?

# Questions?

