# BIOHOUSE

FAKULTA
ARCHITEKTURY
ČVUT V PRAZE

t?f
The Why Factory

**1 Introduction**

**2 What is the BioHouse?**

**3 The Czech House**

**4 What is our impact?**

**5 Materials**

**6 Next House**

**7 Far Future House**

**8 Conclusion & what‘s next?**

# 1
# INTRODUCTION

# 1.1
# THE RISING URGENCY

**We are draining the world's resources faster than ever. How much time do we have, what are the figures and what are the consequences of our actions?**

## Waste managment

# 2 010 000 000 tons

**of waste per year, this number has increased by 300% since 2009**

[Source: The World Bank]

## Drinking water shortage

# 771 000 000

**people with no drinking water**

[Source: The World Bank]

[Source: Green.hr]

# Environmental pollution

## 9 000 000

**premature deaths due to pollution**

[Source: The World Bank]

# Deforestation

## 14 000 000

**hectares of forests lost each year**

[Source: Wikipedia]

[Source: Worldanimalfound]

## Global warming

# +1,14°C

**temperature increase since 1880**

[Source: Climate.gov]

[Source: Sweep.net]

# 1.2
# EVOLUTION OF LIVING

House through the years, sense of urgency and the need to act

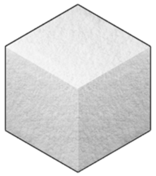
# Primitive dwellings

**hunting & gathering, nomadic way of life**

**temporary buildings & caves**

wood

bones



hide

10000 bc

9000 bc

8000 bc

7000 bc

6000 bc

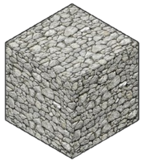
[Source: Human settlements, Science Direct]

# Compact settlements

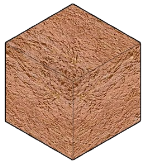
**rural living, agriculture**

## wood

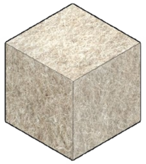
## stone



## mud



## thatch



3000 bc

2500 bc

2000 bc

1500 bc

1000 bc

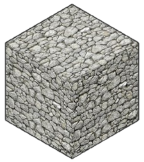
[Source: Human settlements, Science Direct]

# Age of empires

**cities, individual rooms, multiple stories, first city planning**

wood

stone



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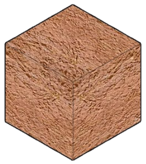
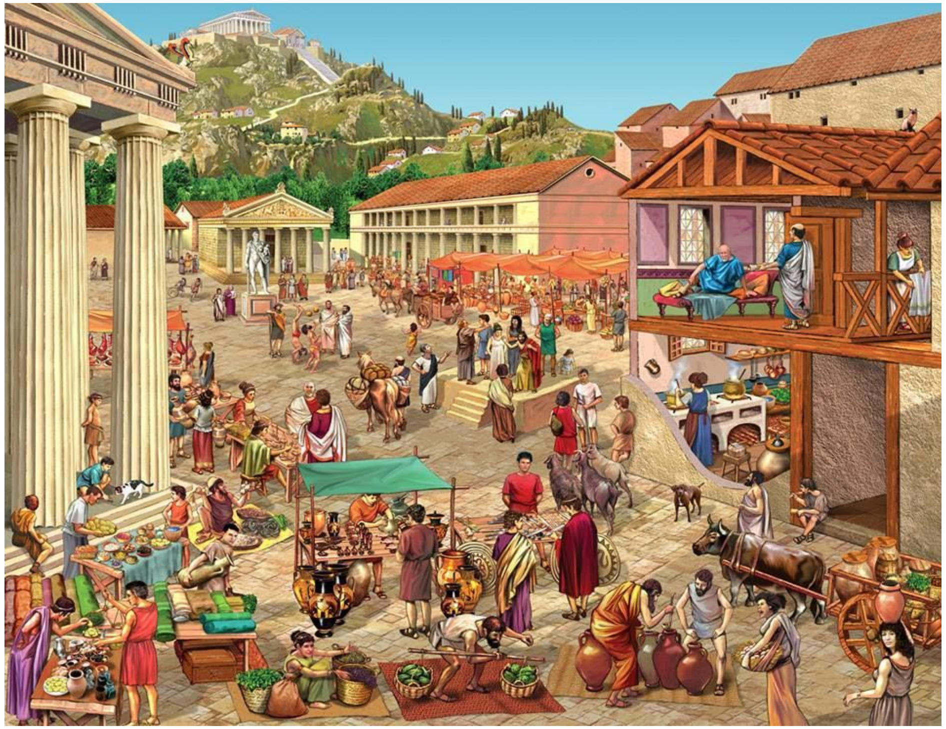


marble



1000 bc

750 bc

500 bc

250 bc

0

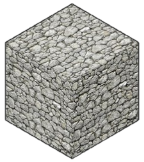
[Source: Human settlements, Science Direct]

# Medieval society

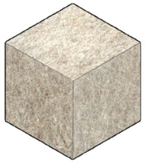
**moderate living, cities build walls**

## wood

## stone



## thatch



500 ac

750 ac

1000 ac

1250 ac

1500 ac

[Source: Human settlements, Science Direct]

# Renaissance

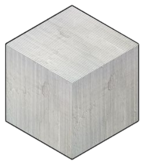
**Rise of high class, material trade, decoration**

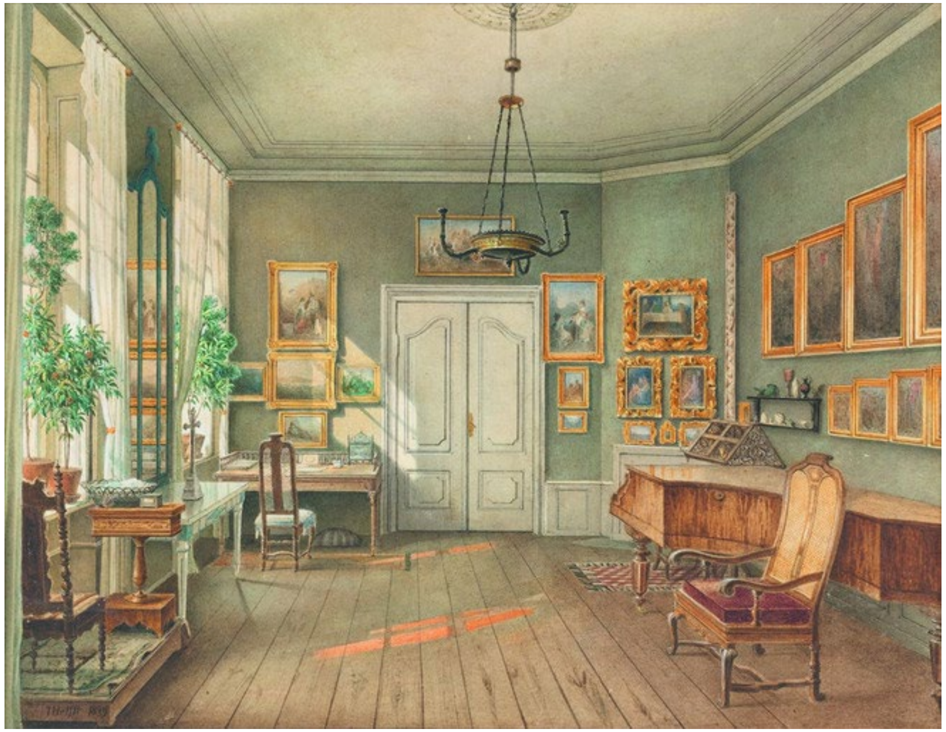
**wood**

**stone**

**brick**

**plaster**





1500 ac

1550 ac

1600 ac

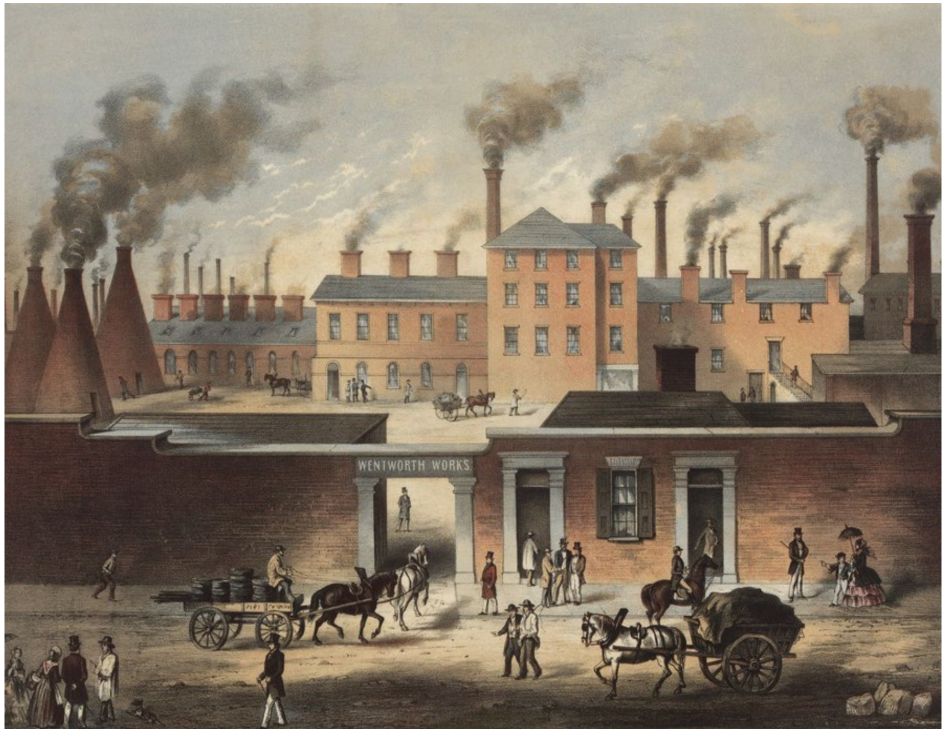
1650 ac

1700 ac

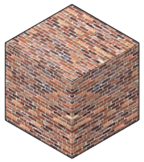
[Source: Human settlements, Science Direct]

# Industrial revolution

**Innovations, steam engine,**

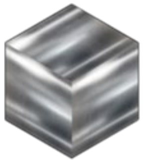



brick



cast iron

steel



1750 ac

1800 ac

1850 ac

1900 ac

1950 ac

[Source: Human settlements, Science Direct]

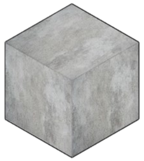
# Modernist dream

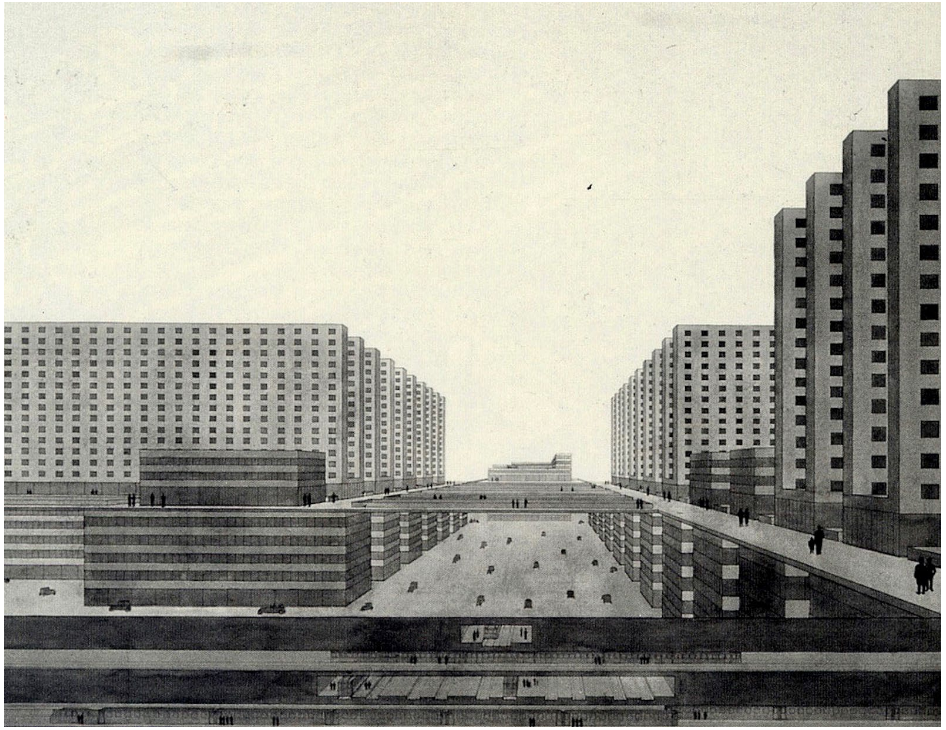
deepening efficiency, seeking progress

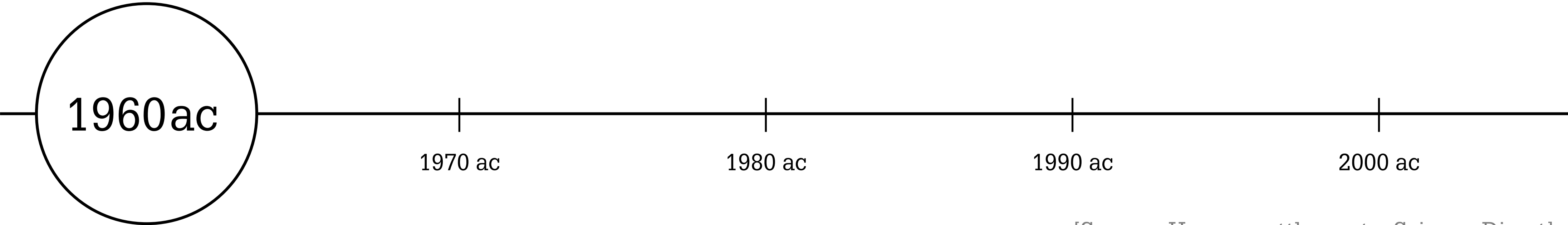
cast iron

steel

concrete





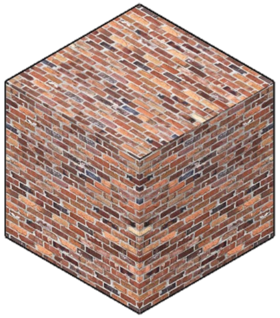



[Source: Human settlements, Science Direct]

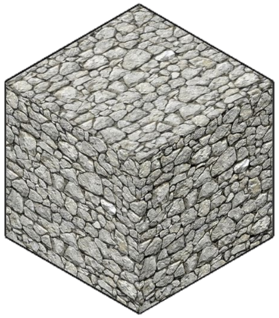
# Forgotten materials

wood

brick



stone



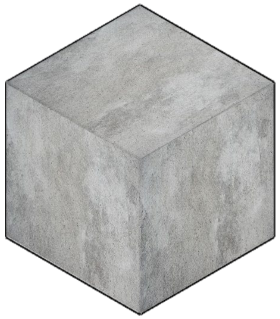
straw

# New materials

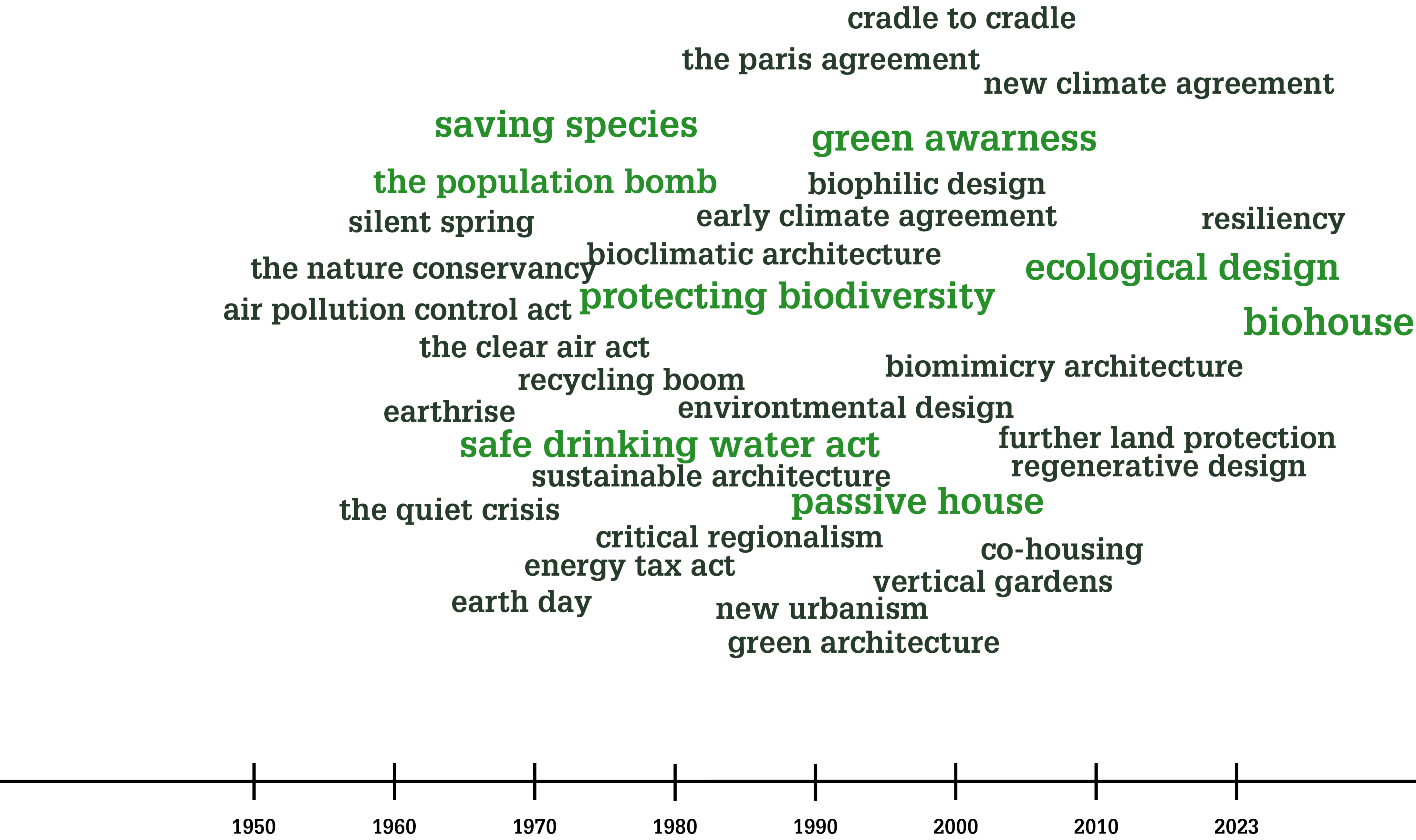
cast iron

steel

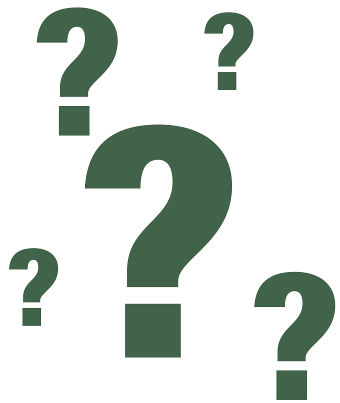
concrete



# The green dream of 60‘



# The World of today



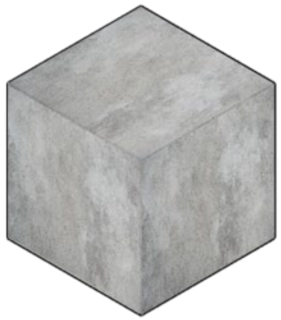
2023 ac

# Materials of 2023

**cast iron**

**steel**

**concrete**

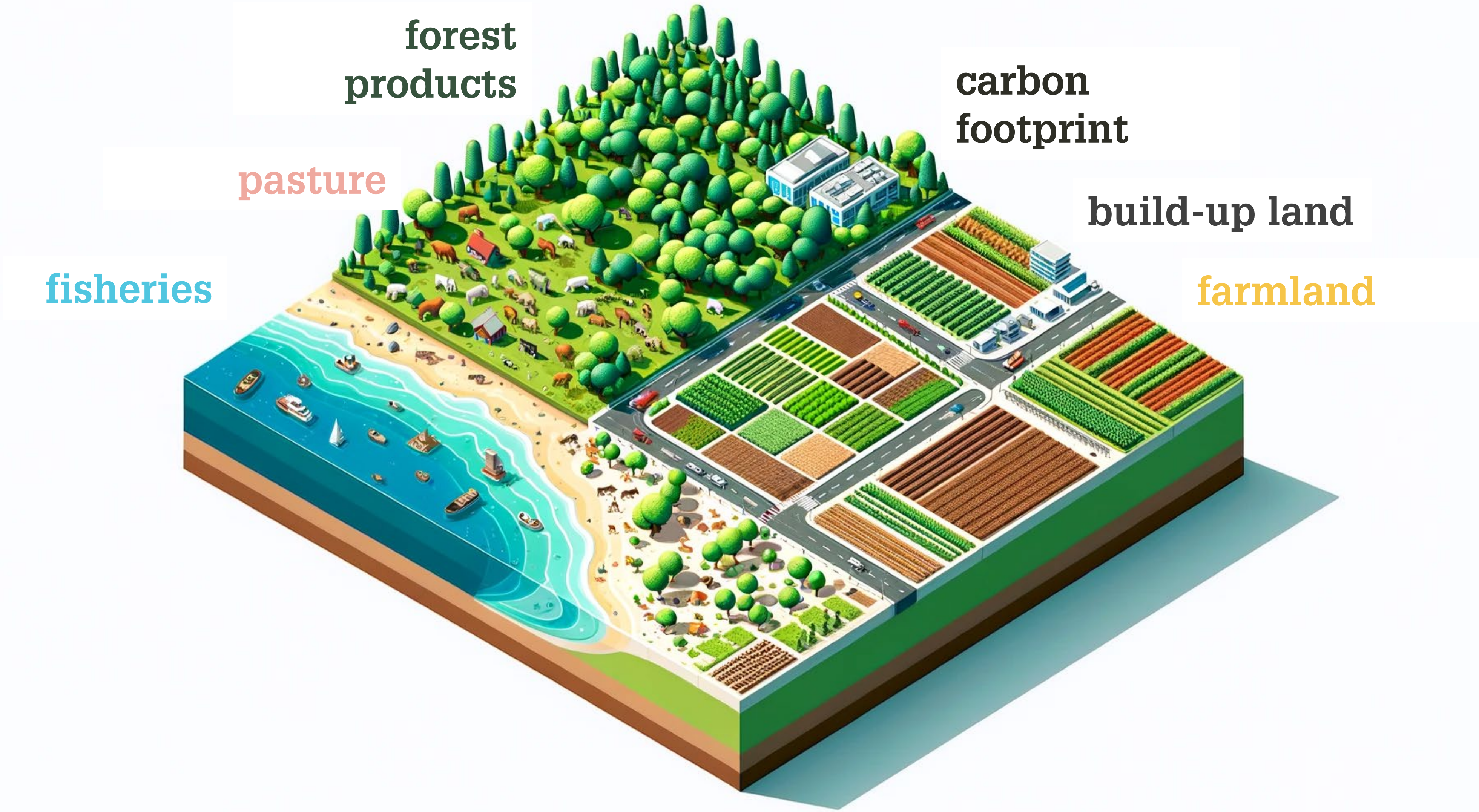


**plastic**

# HOW DO WE QUANTIFY THE RISING URGENCY?

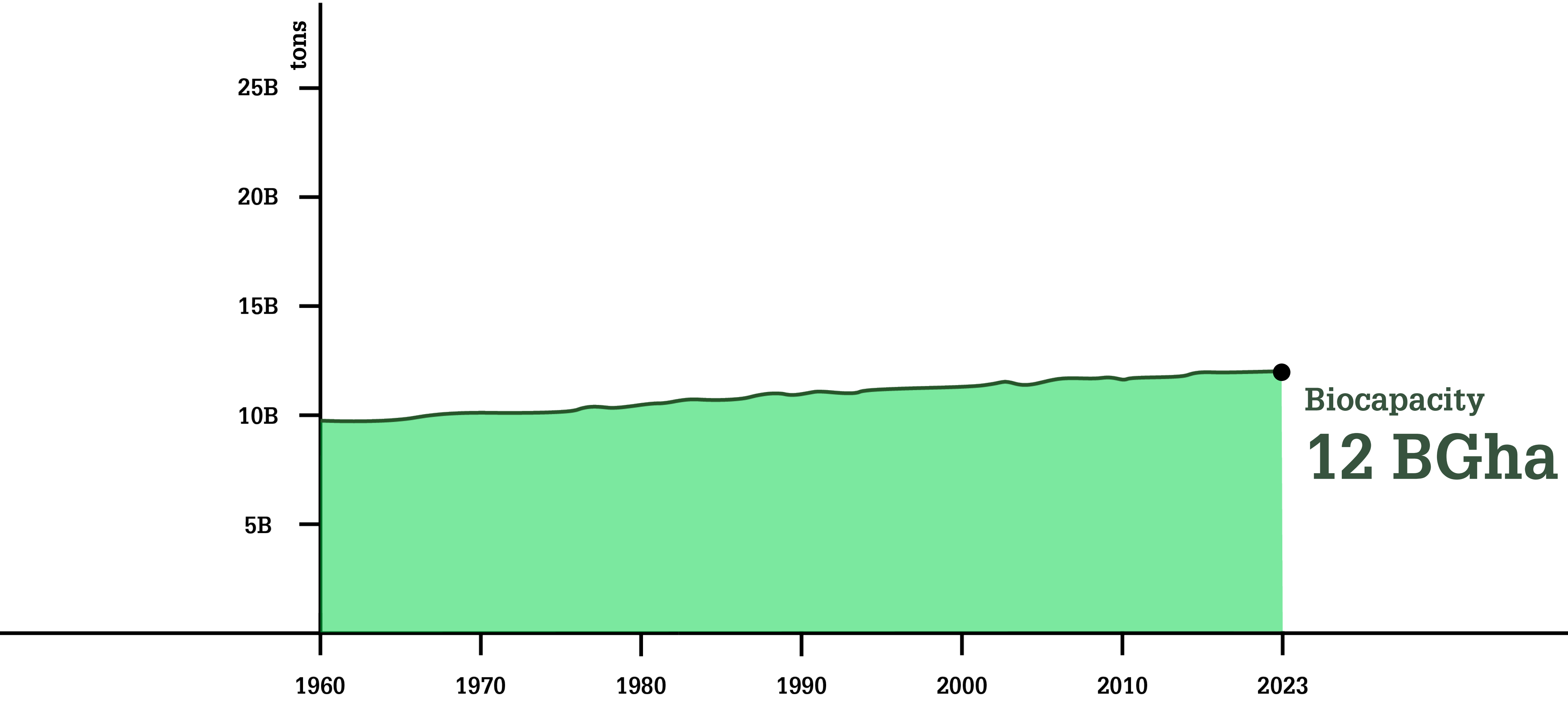
# BY COMPARING THE EARTH'S BIOCAPACITY VS OUR ECOLOGICAL FOOTPRINT

# Biocapacity of earth



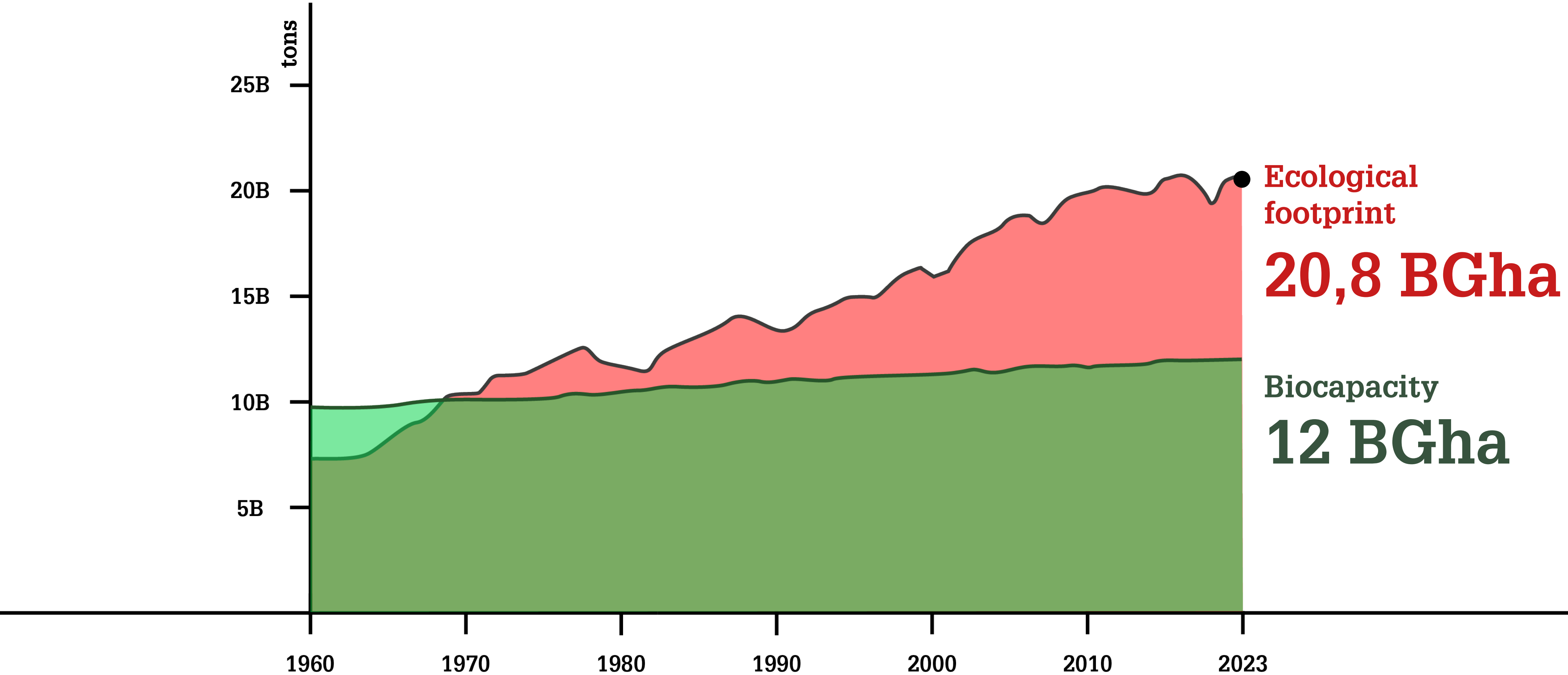

[Sources: Footprintnetwork.org]

## Biocapacity of earth



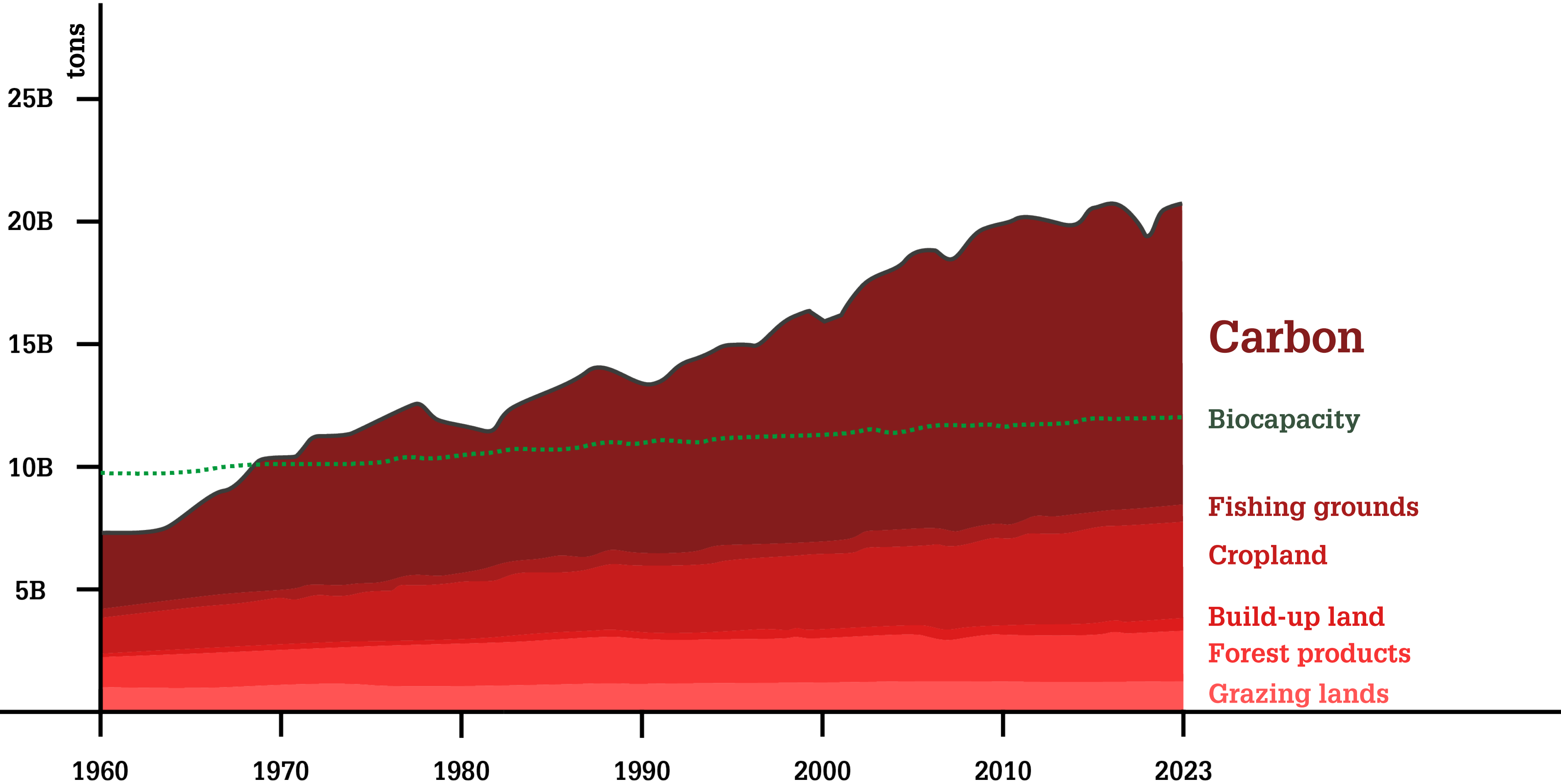

[Sources: Global Footprint Network]

## Ecological footprint




[Source: Global Footprint Network]

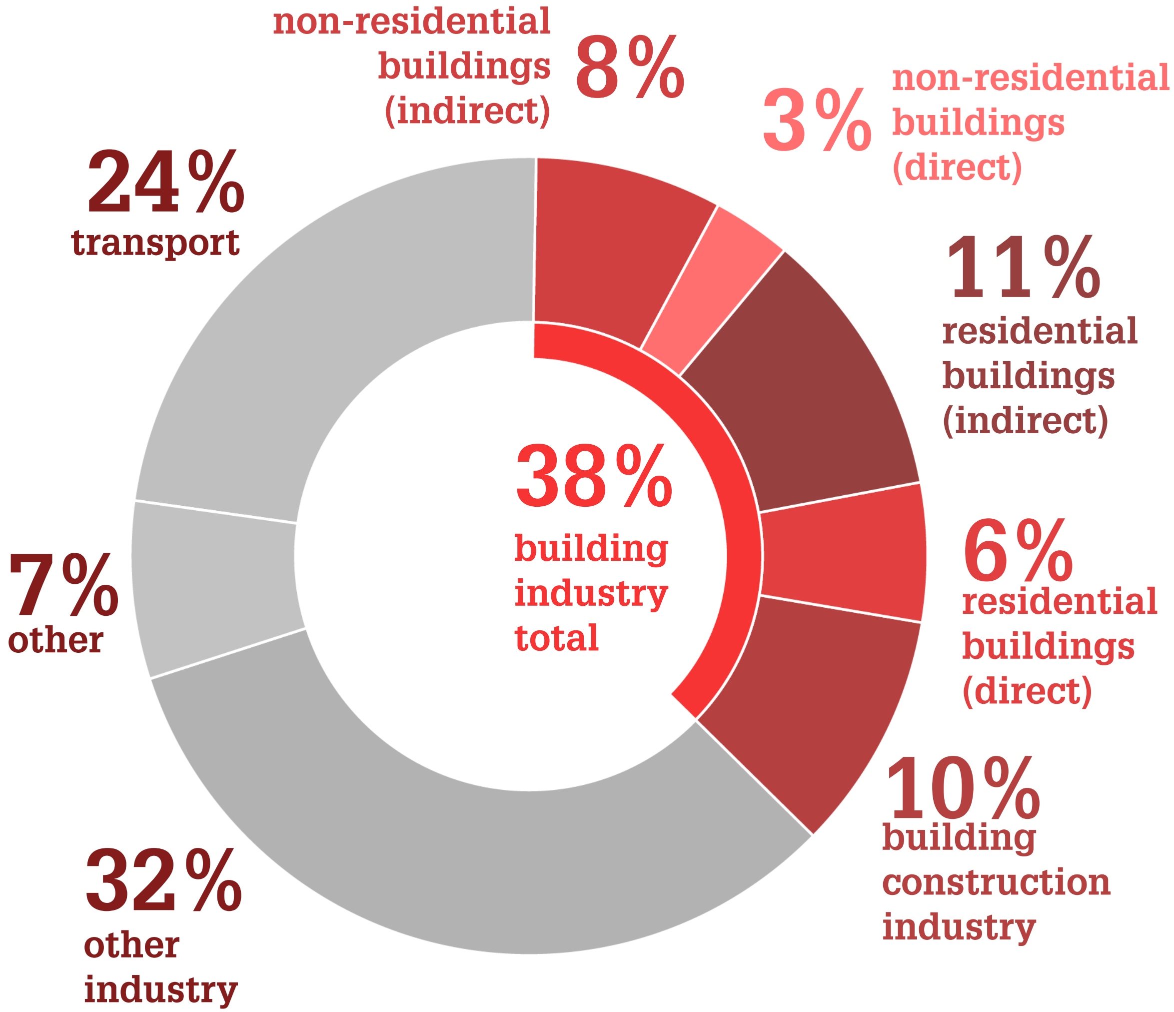
# Ecological footprint




[Source: Global Footprint Network]

## Carbon footprint in depth

# 17% of carbon footprint as a result of the residential sector




[Source: Rise in Carbon Emissions, Brinknews.ocm]

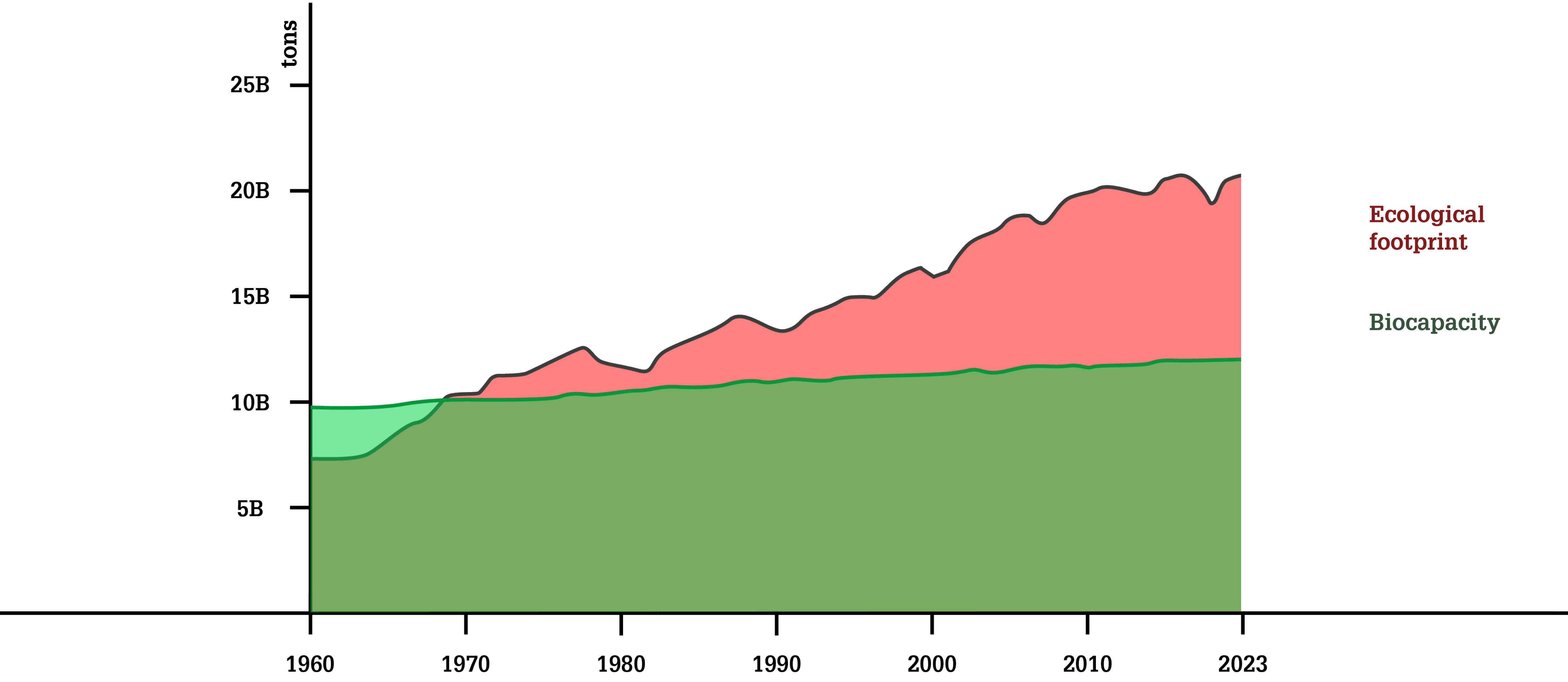
**As we go through the human history, we come to realize that our fast pace momentum has brought us materials of a big potential, but also danger.**

# SO HOW DO WE REDUCE OUR FOOTPRINT?

# BY LOOKING BACK AND BECOMMING BIO AGAIN?

# 2
# WHAT IS THE BIOHOUSE?

# Biohouse as a key to restoring the balance




[Source: Global Footprint Network]

## What is a house?

**shelter**

structure

insulation

plumbing

wiring

openings

furniture

...

## What should be the BioHouse?

**shelter**

adjustable

self-repairable

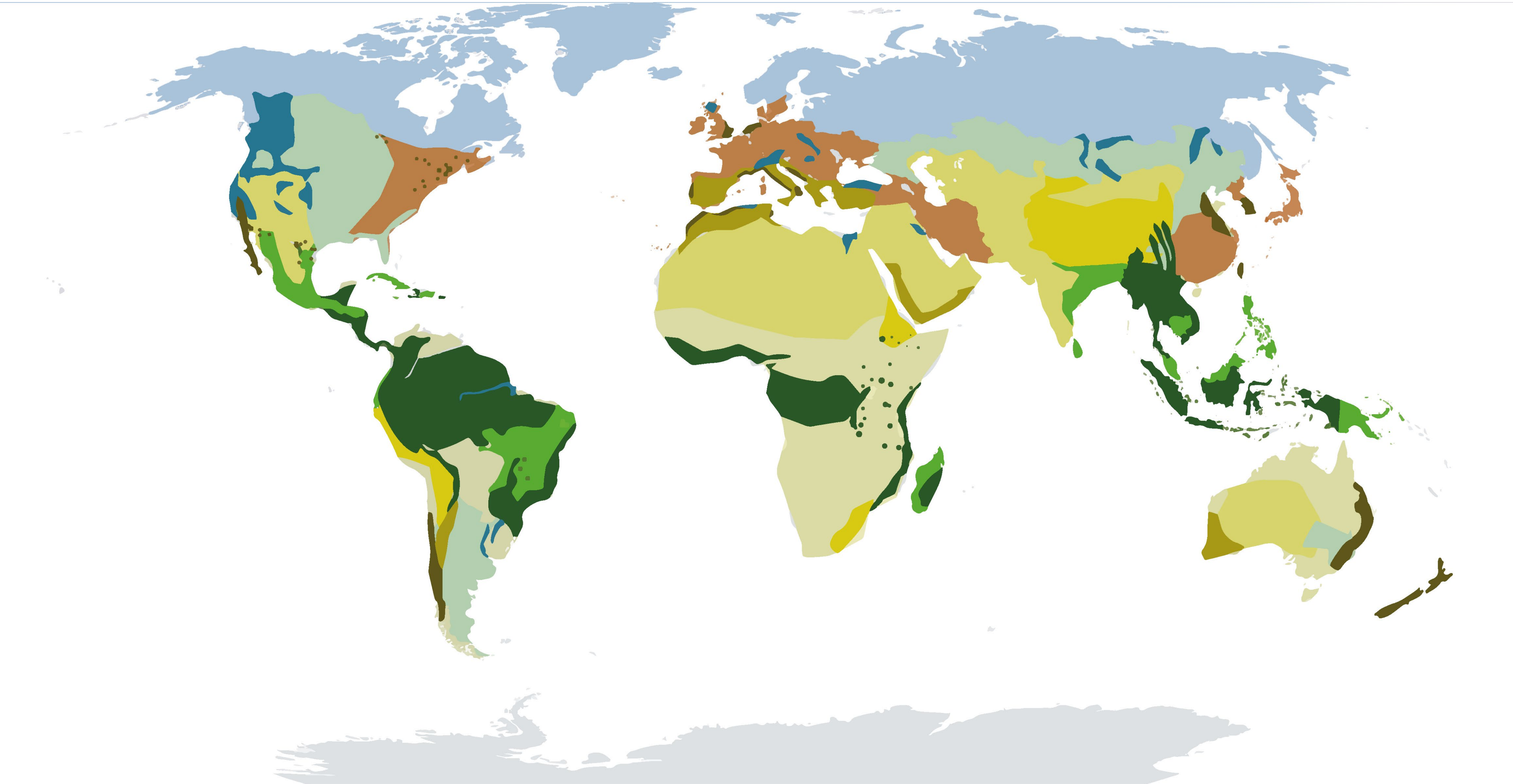
biofriendly

biodegredable

emission-free

**adaptable**

# Map of world biomes



Temperate Grasslands & Savannas

Tundra & Taiga

Temperate Broadleaf & Mixed Forest

Temperate Conifer Forest

Tropical & Subtropical Grasslands, Savannas & Shrublands

Tropical & Subtropical Mois t Broadleaf Forest

Tropical & Subtropical Dry Broadleaf Forest

Moutain Grasslands and Shrublands

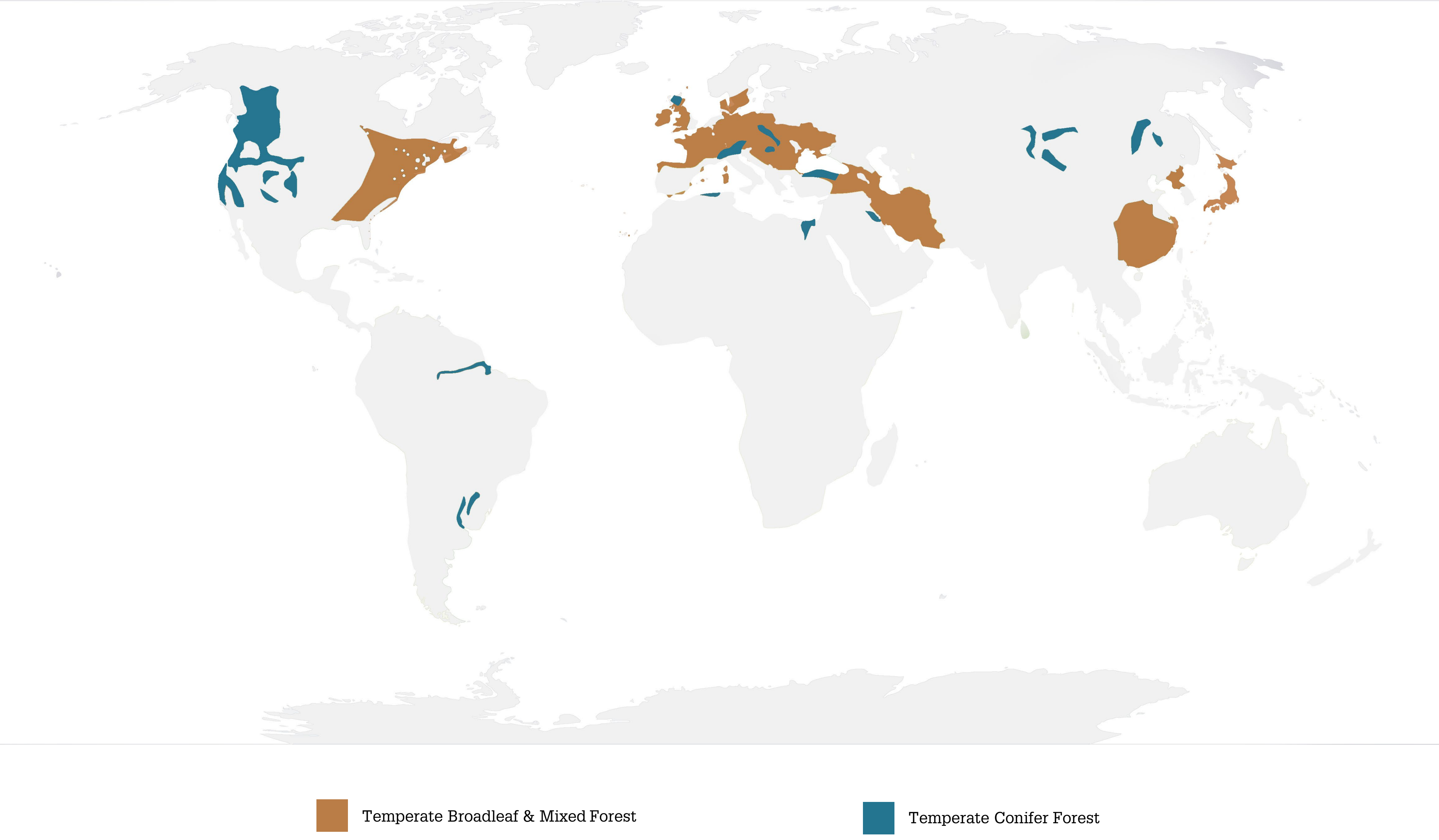
Mediterranean Forest, Woodlands & Scrub

Mangroves

Desert and Xeric

[Source: Biotopia]

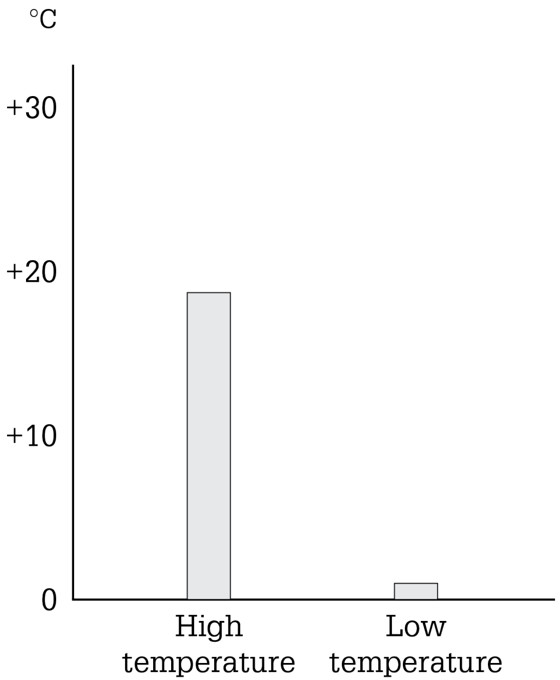
# The temperate biomes



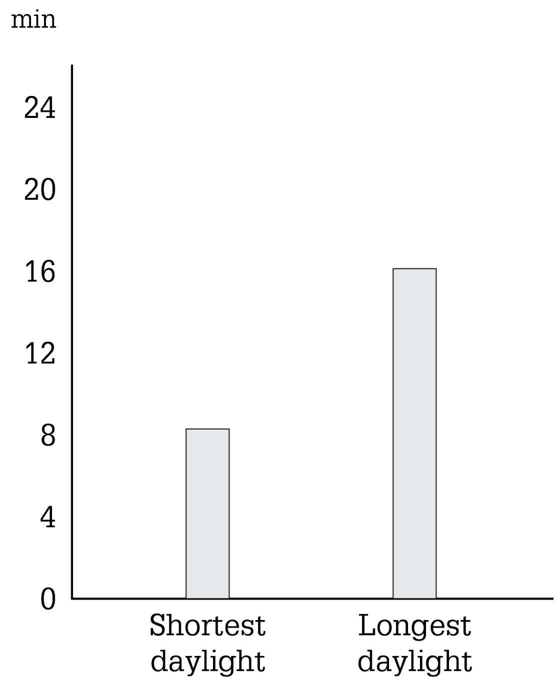

[Source: Biotopia]

# The temperate biome – Average weather conditions

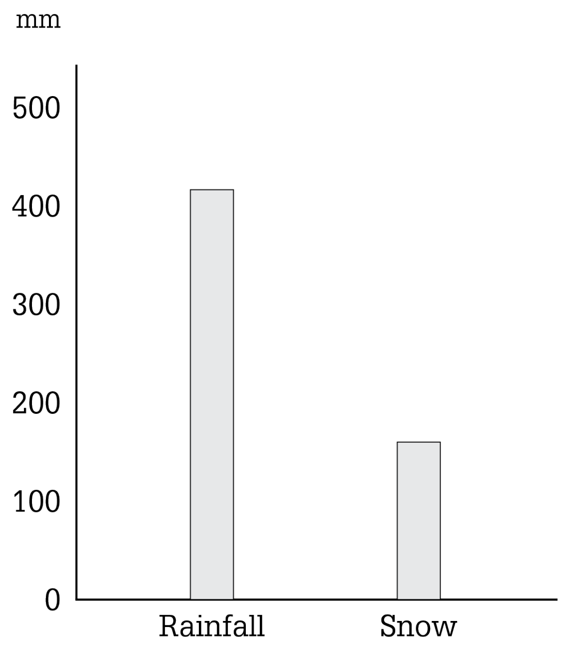
### Average temperature




### Amount of daylight during the year




### Amount of average rain and snowfall




[Source: Climate-data.org]

**As we go through the essence of BioHouse, we set our goal. To reduce our footprint. To restore the balance. Anywhere in the world.**

# BUT HOW DO WE DO THAT?

# WE NEED TO CHANGE THE WAY WE LIVE

# 3

# THE CZECH HOUSE

# 3.1

# THE AVERAGE HOUSEHOLD

**What does the average household look like? How many people live there and what area do we need for our lives?**

**Digging down into the statistics of Czech living provides crucial data for further understanding of the way we live.**

# Typologies

The total number of the households in the Czech Republic is 4.8 mil. As a household is considered any ihabitated space including recreational households.

**4.8mil**
**Total number of households**

[Source: Scitani lidu, 2021]

[Source: Unsplash]

# Typologies

Number of primary households in the Czech Republic is 4.35 mil.

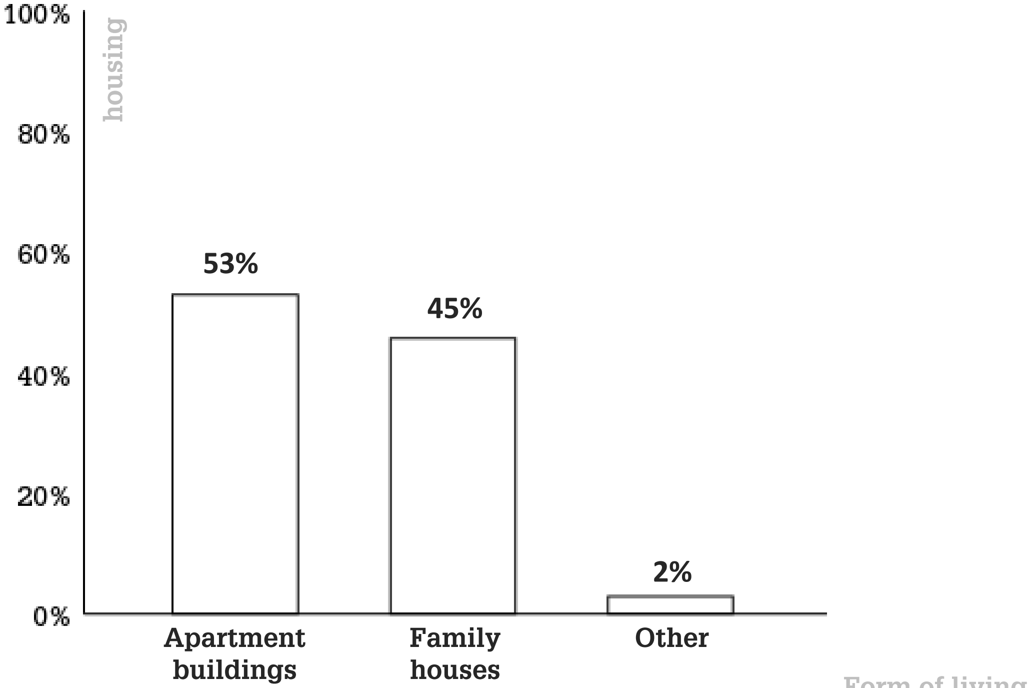
**4.35mil**
**Number of primary households**

[Source: Scitani lidu, 2021]

[Source: Unsplash]

# Typologies

In the Czech Republic, the majority of the housing is provided by apartment buildings and family houses.



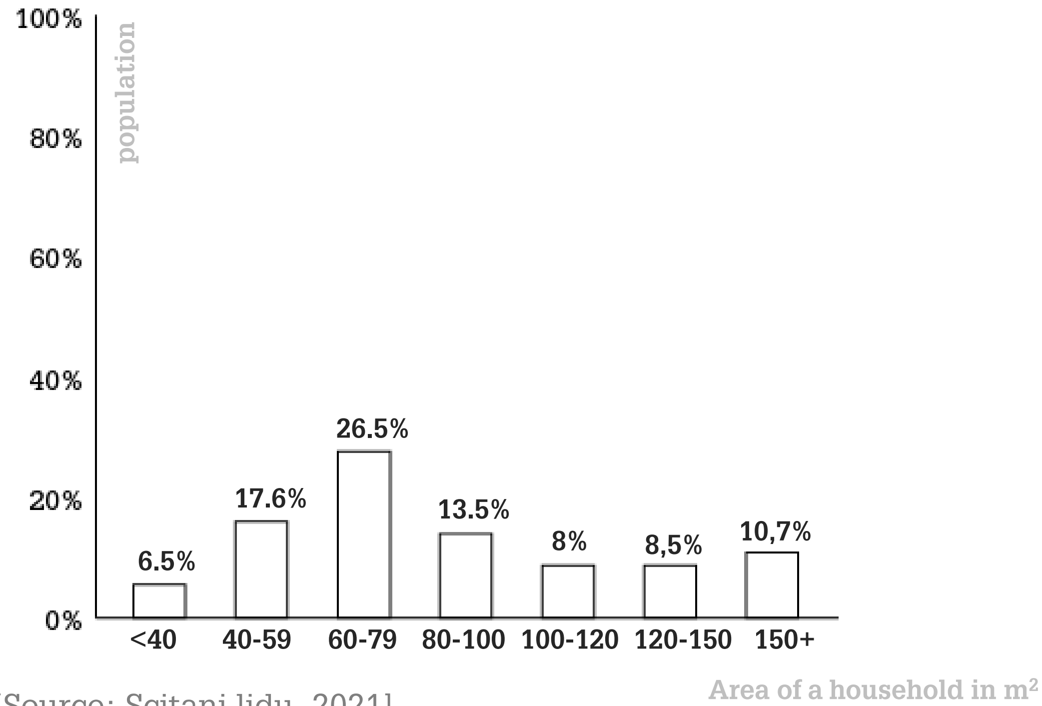

[Source: Scitani lidu, 2021]

[Source: CZSO]

# Occupied area

The average floor area of a Czech household is 87 m².

## 87 m²
## Average household area




[Source: Scitani lidu, 2021]

[Source: Unsplash]

# Typologies

Czechs are nation of cottagers. In terms of their number of recreational homes per inhabitant, only the Swedes surpass the Czechs in the world.

**450 000**

**Number of recreational households**

[Source: Unsplash]

# Typologies

96.7 m² is the average area of a Czech household including primary and secondary homes.

**96.7 m²**
**Average floor area with recreational homes**

[Source: Scitani lidu, 2021]

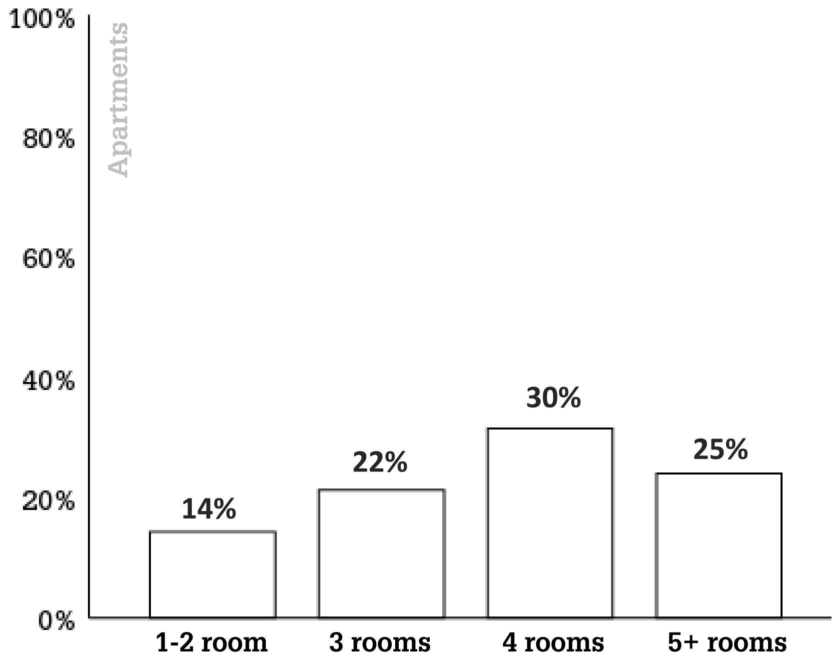

[Source: Unsplash]

# Apartment layout

The average layout of apartment is the configuration with 2 bedrooms, living room and separated kitchen.

**3+1**

**Average household layout**




[Source: SZSO, 2022]

Apartment layout

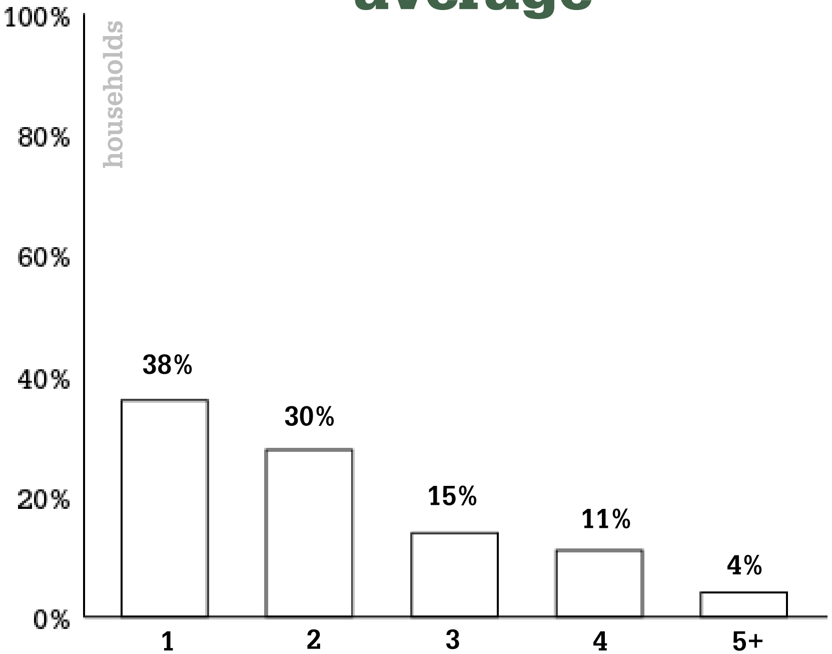
[Source: Pexels]

# Occupancy

The average member size of a Czech household living in apartment is 2.3 people.

**2.3**

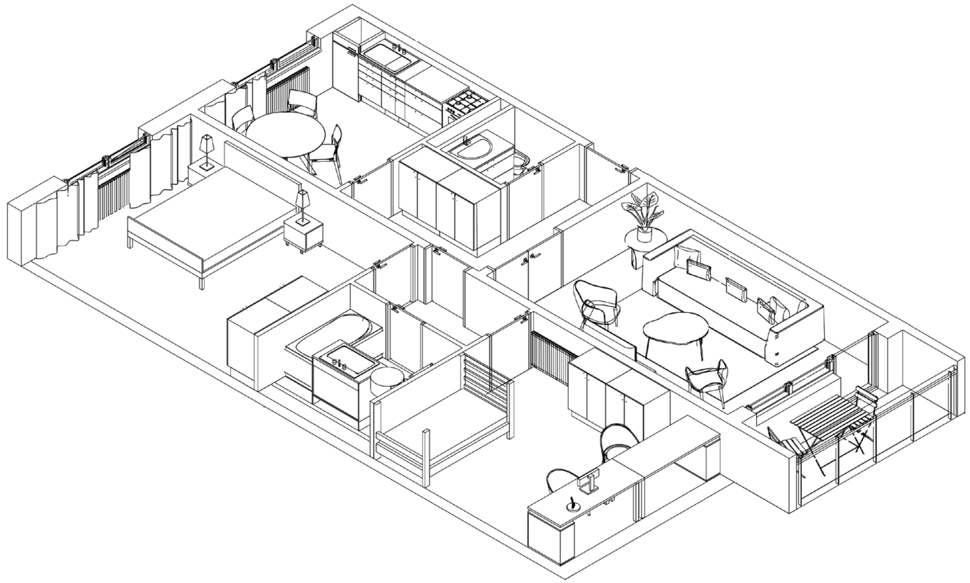
**People per household in average**




[Source: SZSO, 2022]

[Source: Pexels]

# Typical household



**96.7 m²**
**Household floor area**

**3+1**
**Household layout**

**2.3**
**People per household**

# WHAT IS IT MADE OF?

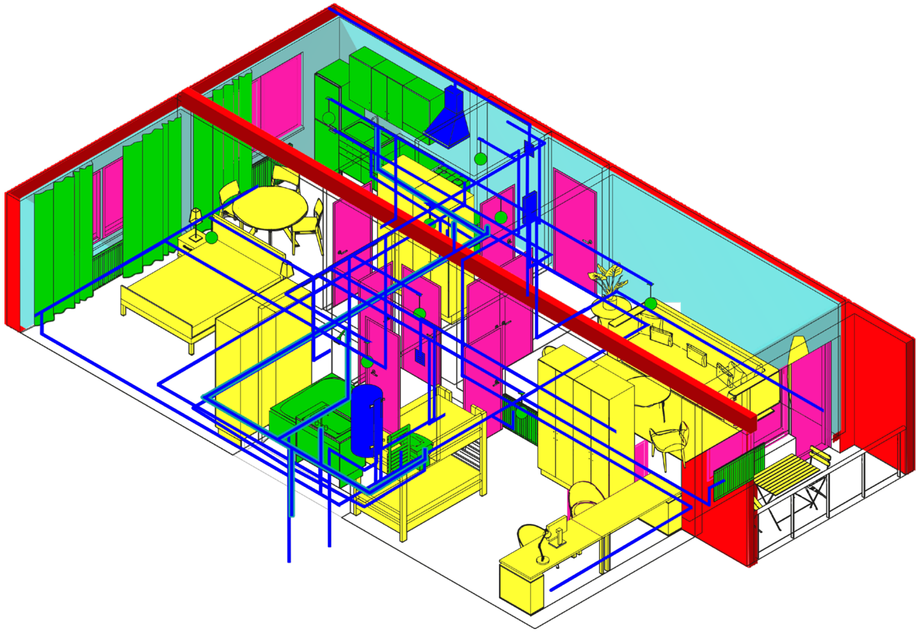
# 3.2

# WHAT IS IT MADE OF?

In order to understand the house of today, it is necessary to break it down into elements.

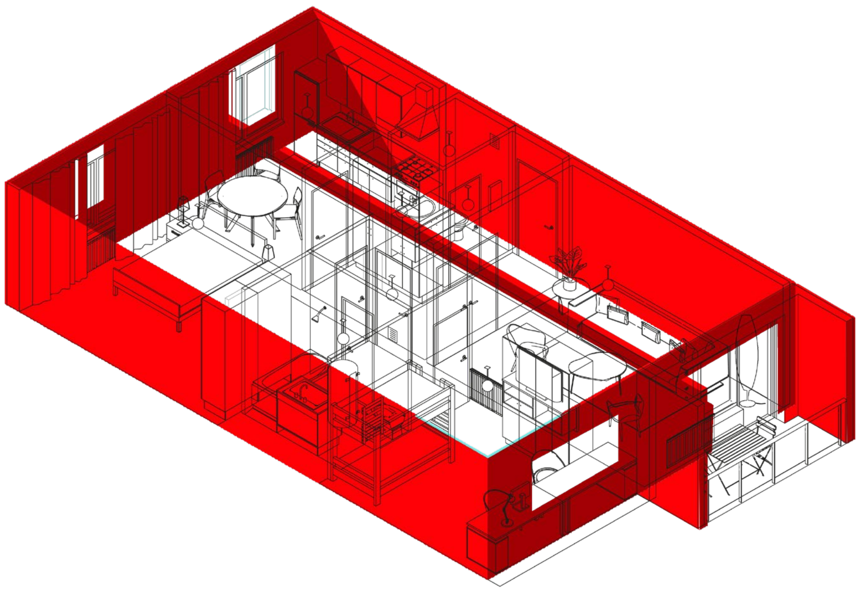
Elements are then sorted into categories, from which data of needed resources are extracted.

# Element categories



- Structural
- Insulation
- Services
- Openings
- Fixed furniture
- Flexible furniture

# Structural elements



## Structural

Loadbearing panel

Beam

Reinforcement

Loadbearing opening panel

# Structural elements

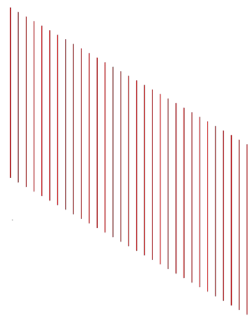
## Panel

**Composition:**

| | |
|---|---|
| Cement | 0.0043 $m^3$ |
| Sand | 0.0086 $m^3$ |
| Aggregate | 0.0172 $m^3$ |

**Life span:** 75 + years

## Steel reinforcement

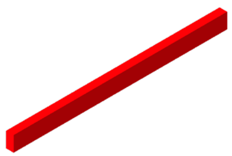


**Composition:**

| | |
|---|---|
| Steel | 0.005$m^3$ |

**Life span:** 75 + years

## Beam

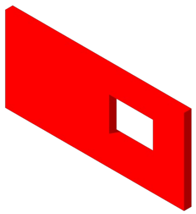


**Composition:**

| | |
|---|---|
| Concrete | 0.0086$m^3$ |

**Life span:** 75 + years

## Panel

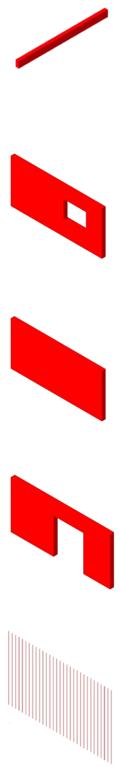


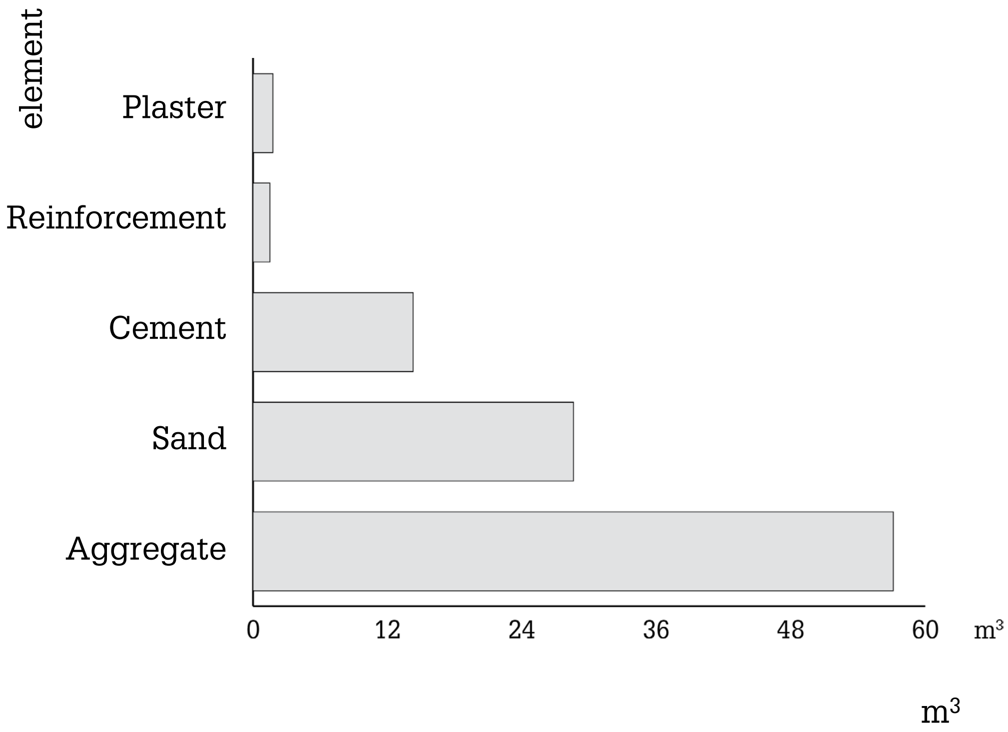
**Composition:**

| | |
|---|---|
| Concrete | 0.028$m^3$ |

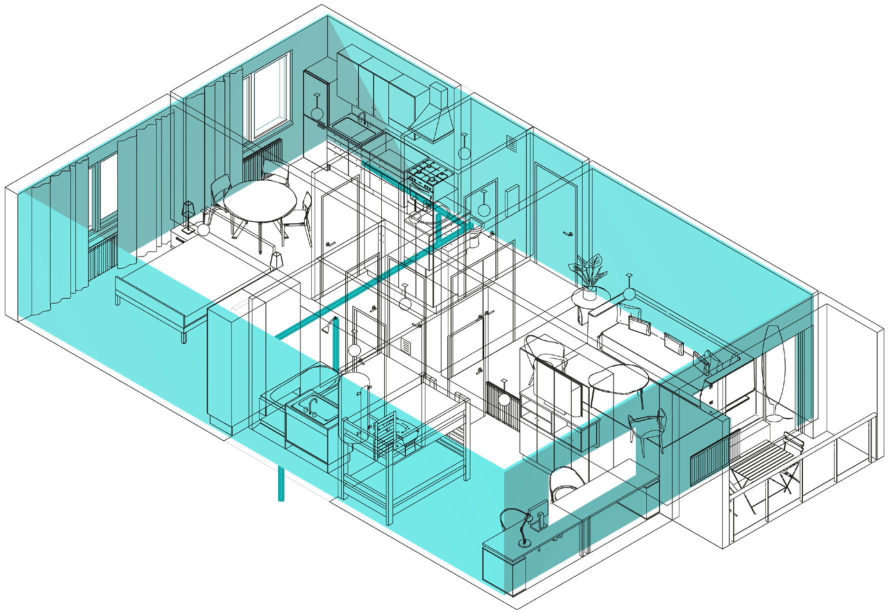
**Life span:** 75 + years

# Structural elements





# Insulating elements



## Insulation

PIR

Mineral Wool

# Insulating elements

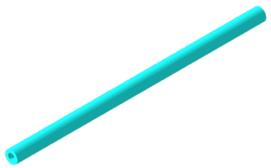
## Rigid wall insulation

**Composition:**

PIR **19.4m³**

**Life span:** **80 + years**

## Pipe insulation

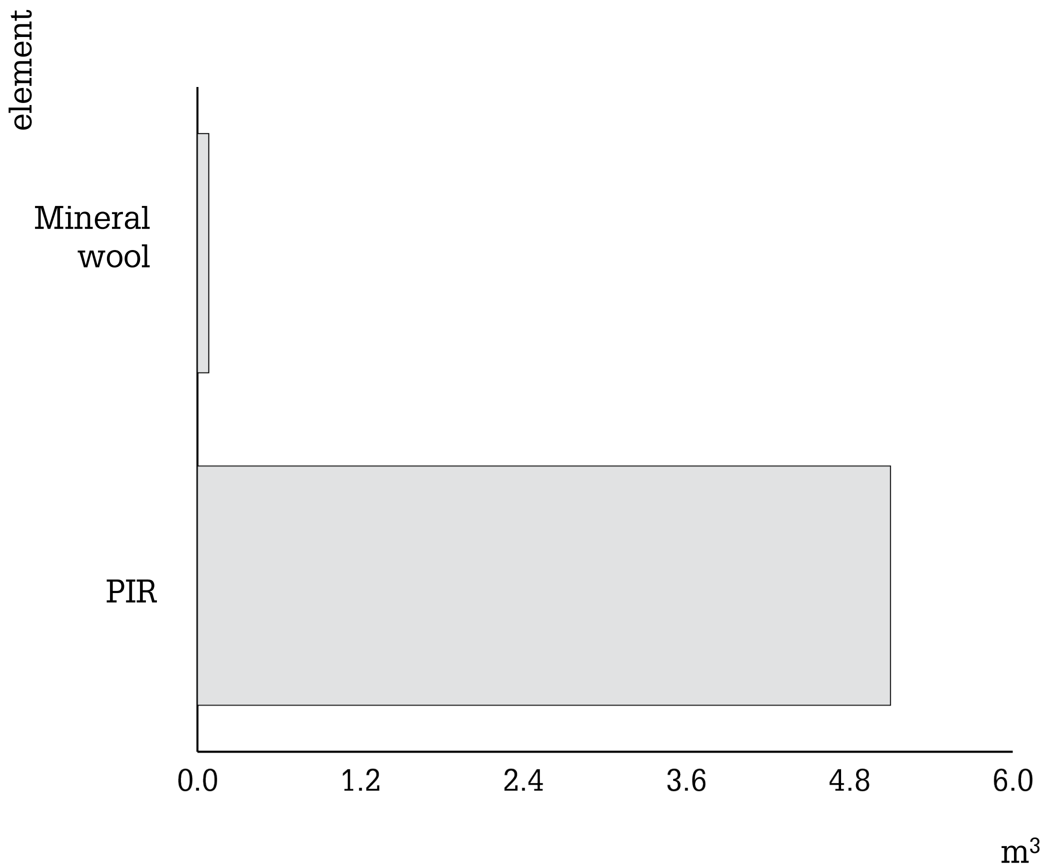


**Composition:**

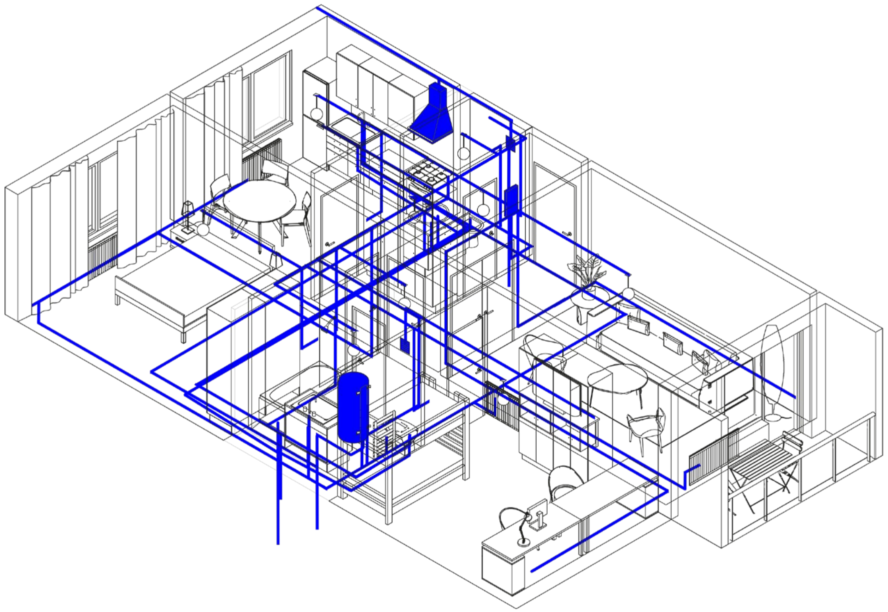
Mineral wool **0.013m³**

**Life span:** **10 + years**

# Insulating elements



# Services



## Services

Boiler

Fuse box

Extractor fan

Bathroom fan

Internet cable

Electric cables

Lighting cables

Gas pipes

Gas pipe parts

Hot water pipes

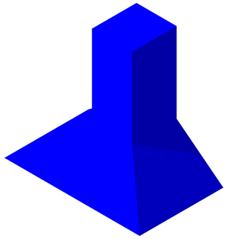
Cold water pipes

Water pipe parts

Waste pipe parts

# Services

## Air absorber

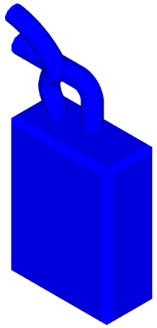


**Composition:**

| | |
|---|---|
| PVC | 0.0124 $m^3$ |

**Life span:** 10 years

## Boiler

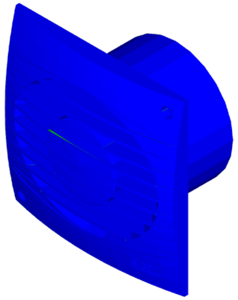


**Composition:**

| | |
|---|---|
| Steel | 0.01$m^3$ |

**Life span:** 15 years

## Bathroom Fan

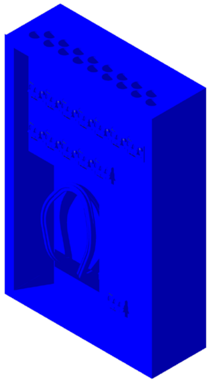


**Composition:**

| | |
|---|---|
| PVC | 0.0003$m^3$ |

**Life span:** 12 years

## Fuse Box



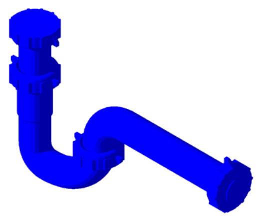
**Composition:**

| | |
|---|---|
| Plastic | 0.0003$m^3$ |
| Copper | 0.000026$m^3$ |

**Life span:** 15 years

# Services

## Plumbing Fittings

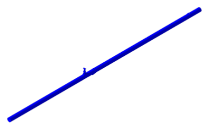


**Composition:**

PVC 0.00124 $m^3$

**Life span:** 65 years

## Cold water

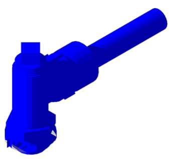


**Composition:**

PVC 0.0018$m^3$

**Life span:** 50 years

## Pressure fittings

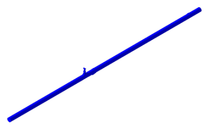


**Composition:**

PVC 0.0003$m^3$

**Life span:** 65 years

## Hot water



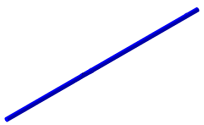
**Composition:**

PVC 0.0018$m^3$

**Life span:** 50 years

# Services

## Cold Water Pipe

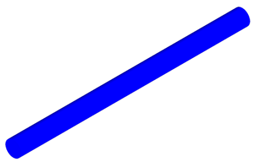


**Composition:**

| | |
|---|---|
| PVC | 0.0018 $m^3$ |

**Life span:** 50 years

## Soil Pipe

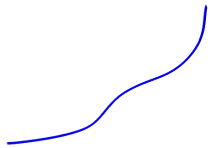


**Composition:**

| | |
|---|---|
| PVC | 0.0124$m^3$ |

**Life span:** 50 years

## Electric Cables

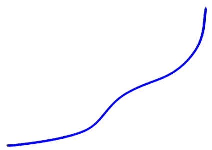


**Composition:**

| | |
|---|---|
| Copper | 0.0001$m^3$ |
| PVC | 0.0004$m^3$ |

**Life span:** 25 + years

## Lighting Cables

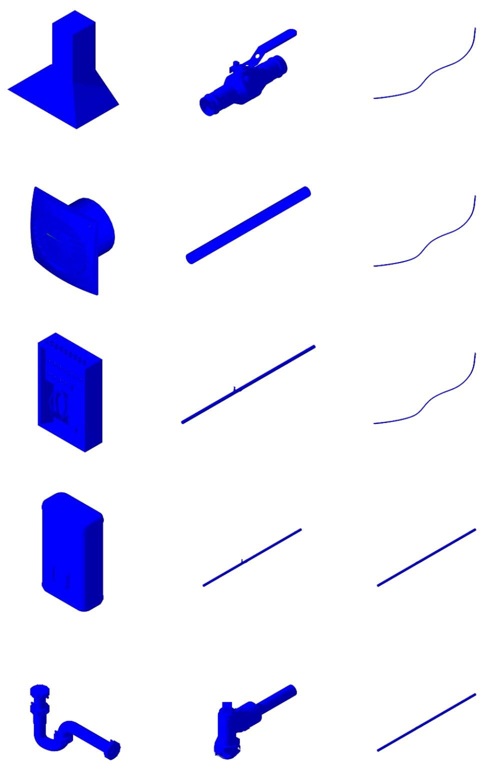


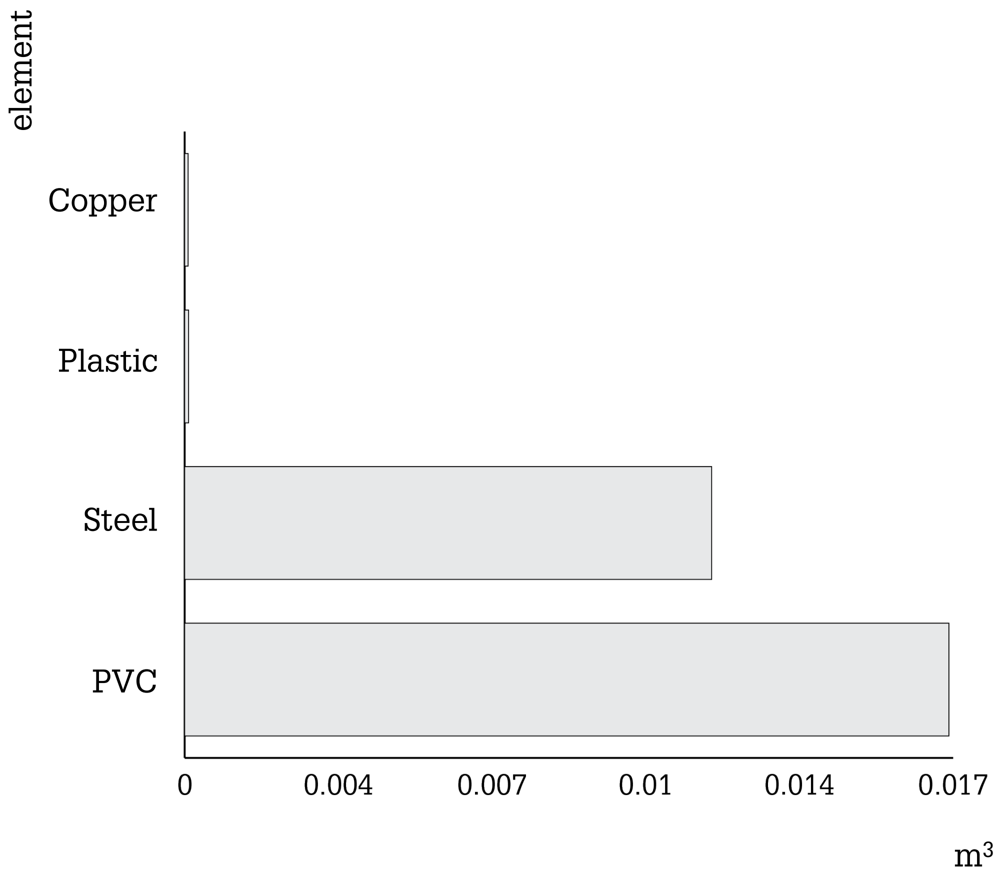
**Composition:**

| | |
|---|---|
| Copper | 0.00005$m^3$ |
| PVC | 0.0002$m^3$ |

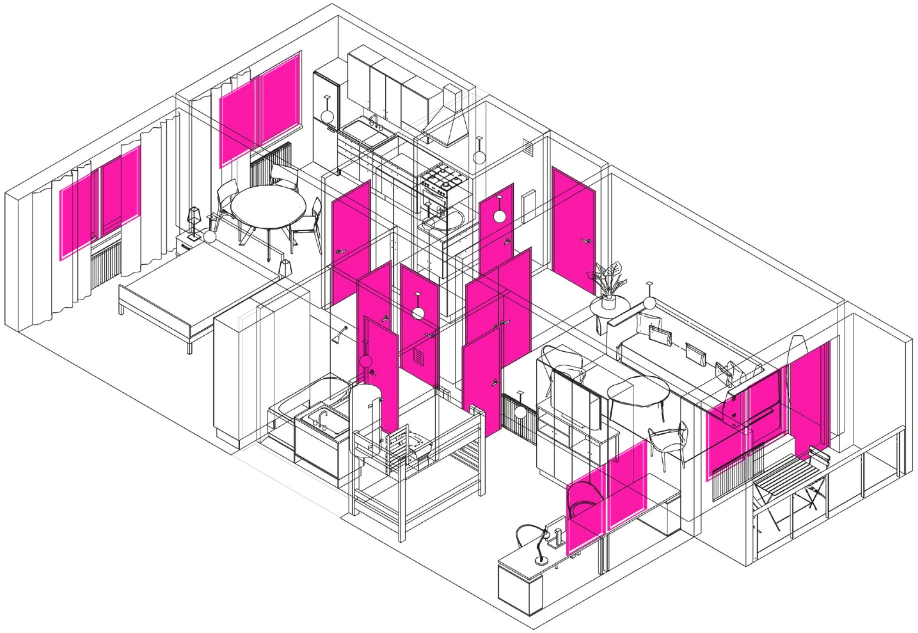
**Life span:** 25 + years

# Services




element
Copper
Plastic
Steel
PVC
0
0.004
0.007
0.01
0.014
0.017
m3

# Openings



## Openings

Door

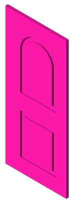
Door Frame

Window Frame

Window Pane

# Openings

## Door

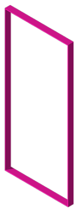


**Composition:**

Wood 0.03 $m^3$

**Life span:** 50 + years

## Door Frame

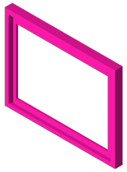


**Composition:**

Wood 0.0086$m^3$

**Life span:** 50 + years

## Window Frame



**Composition:**

PVC 0.005$m^3$

**Life span:** 30 years

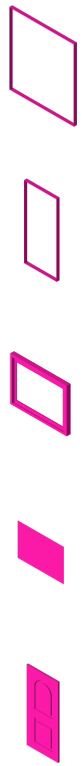
## Glazing

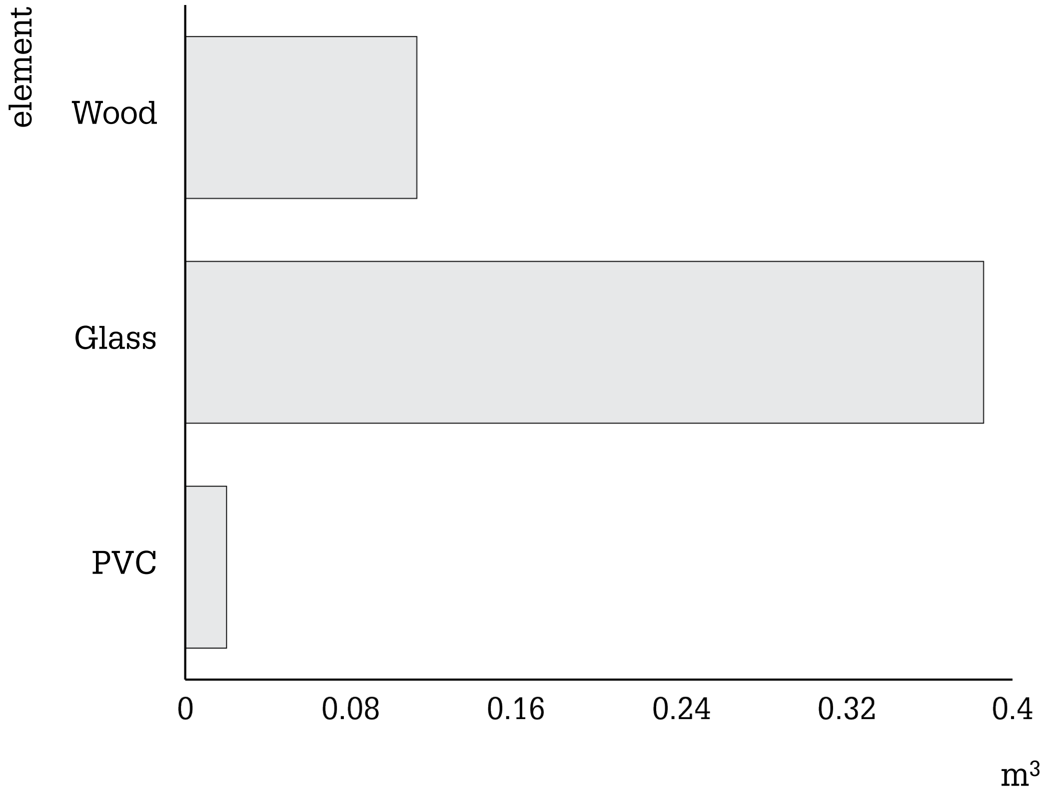
**Composition:**

Glass 0.028$m^3$

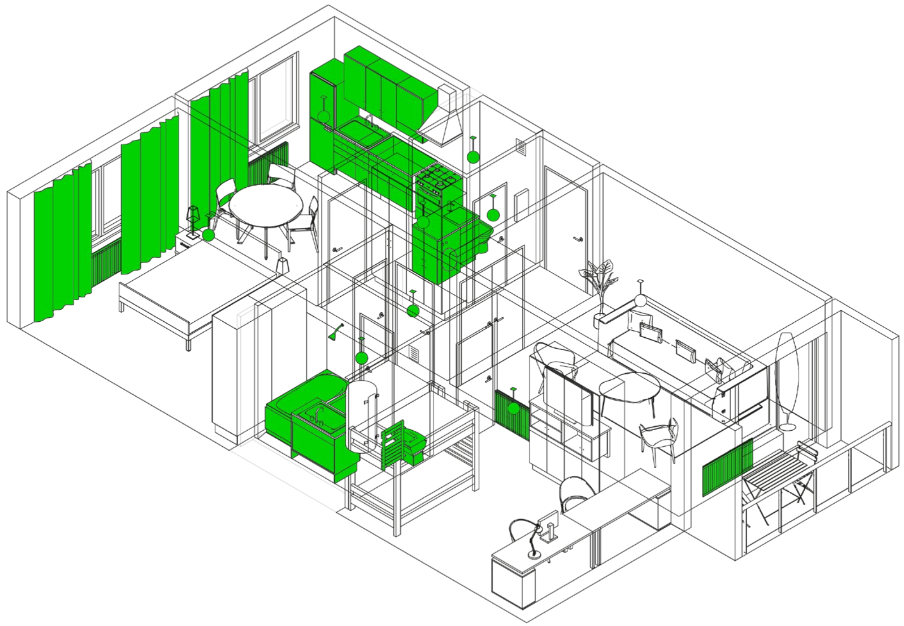
**Life span:** 20 + years

# Openings





# Fixed furniture



## Fixed

Toilet

Bath

Shower

Bathroom Sink

Bathroom Tap

Radiator

Lights

Curtains

Kitchen Cupboards

Kitchen Worktop

Kitchen Sink

Kitchen Tap

Hob

Oven

Fridge

# Fixed furniture

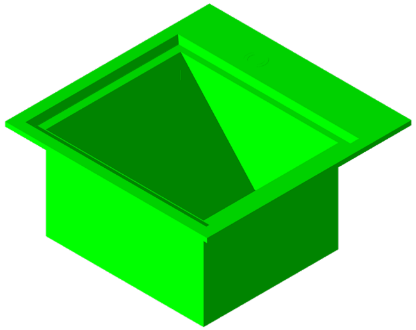
## Toilet

**Composition:**

Porcelain 0.02 $m^3$

**Life span:** 15 + years

## Sink

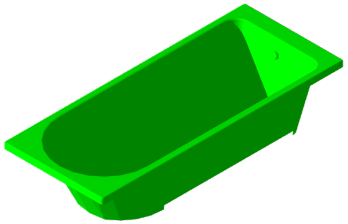


**Composition:**

Porcelain 0.01$m^3$

**Life span:** 20 + years

## Bathtub

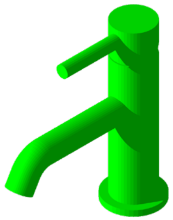


**Composition:**

Acrylic 0.042$m^3$

**Life span:** 20 + years

## Tap



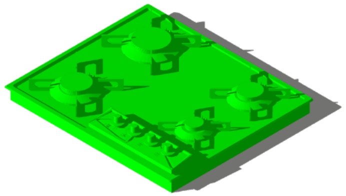
**Composition:**

Stainless Steel 0.0001$m^3$

**Life span:** 15 + years

# Fixed Furniture

## Hob



**Composition:**

| | |
|---|---|
| Stainless steel | 0.001 $m^3$ |

**Life span:** 15 years

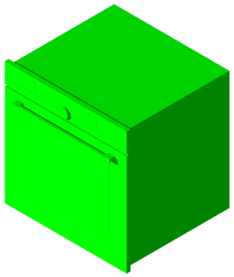
## Kitchen Cupboards

**Composition:**

| | |
|---|---|
| Laminated Chipboard | 0.078$m^3$ |

**Life span:** 20 years

## Oven

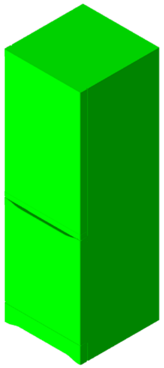


**Composition:**

| | |
|---|---|
| Stainless steel | 0.01$m^3$ |

**Life span:** 15 years

## Fridge



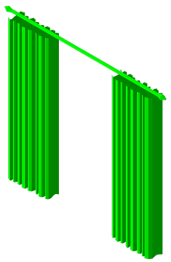
**Composition:**

| | |
|---|---|
| Plastic | 0.033$m^3$ |
| Polyurethane | 0.28$m^3$ |
| Stainless Steel | 0.003$m^3$ |
| Glass | 0.001$m^3$ |

**Life span:** 15 years

# Fixed Furniture

## Curtains

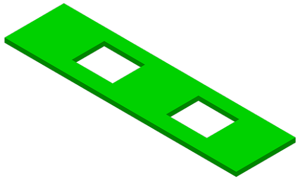


**Composition:**

| | |
|---|---|
| Fabric | 0.0475 $m^3$ |
| Wood | 0.0005 $m^3$ |

**Life span:** 10 + years

## Kitchen worktop

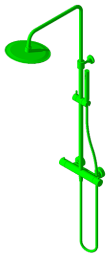


**Composition:**

| | |
|---|---|
| Granite | 0.12$m^3$ |

**Life span:** 25 + years

## Shower



**Composition:**

| | |
|---|---|
| Stainless steel | 0.0001$m^3$ |

**Life span:** 15 years

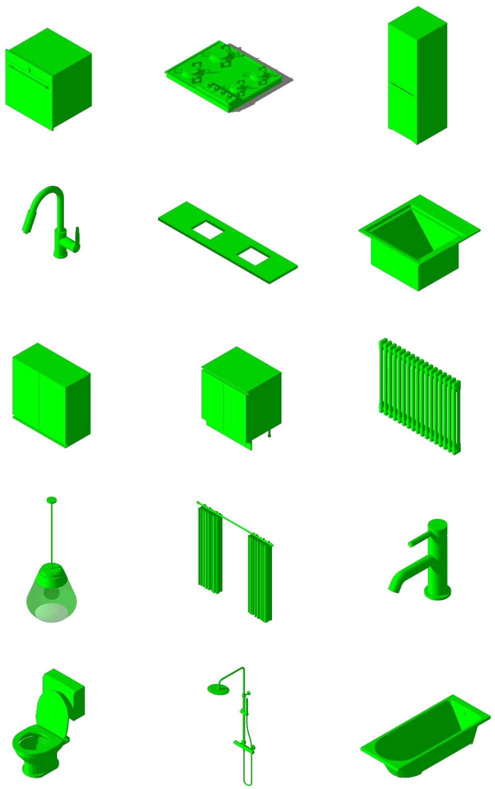
## Lights

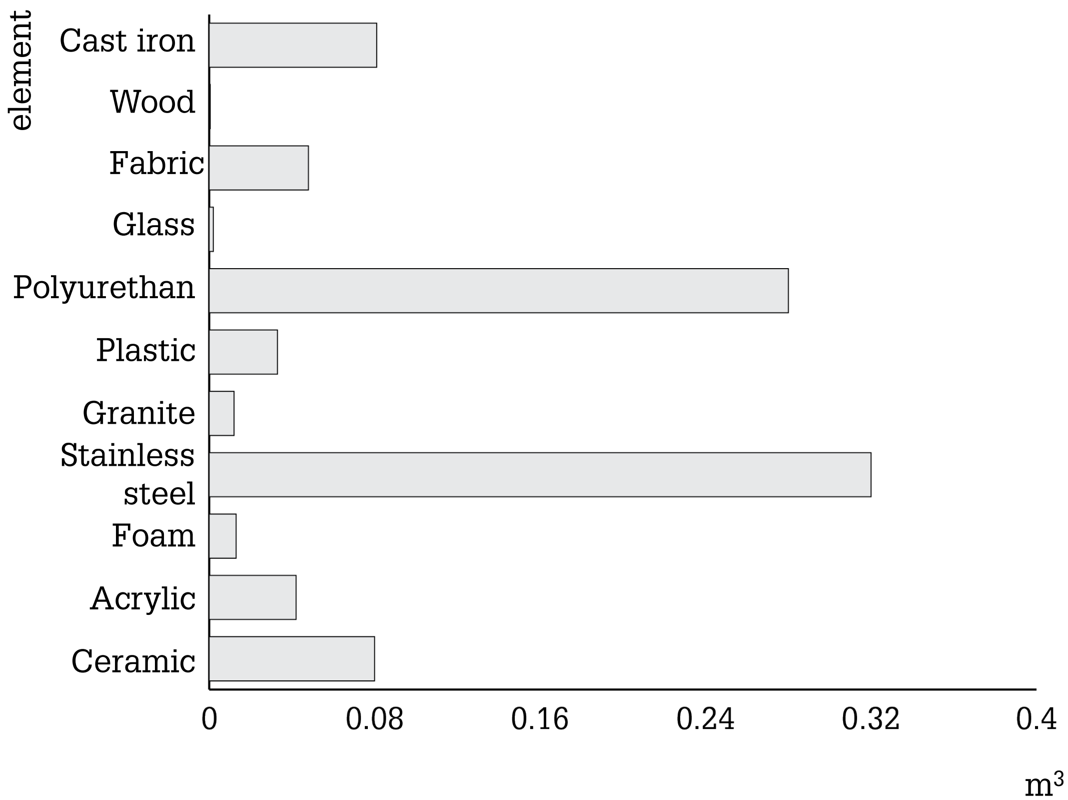
**Composition:**

| | |
|---|---|
| Plastic | 0.00003$m^3$ |
| Glass | 0.00003$m^3$ |

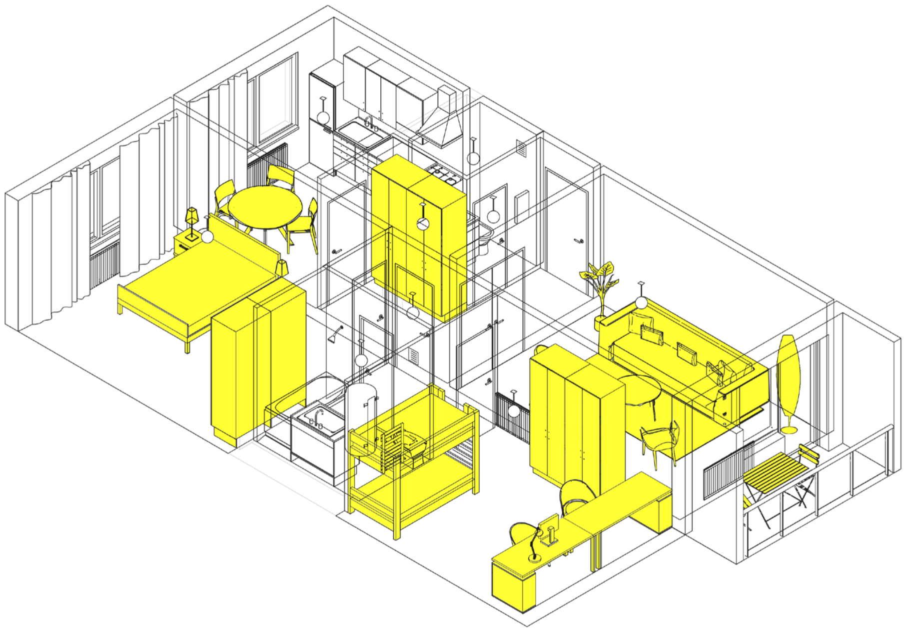
**Life span:** 10 + years

# Fixed Furniture





# Flexible furniture



## Flexible furniture

Double bed

Bunk bed

Bed side table

Bed side light

Desk

Desk chair

PC

Outdoor table

Outdoor chair

Dining table

Dining chair

Sofa

Arm chair

Coffee table

House plant

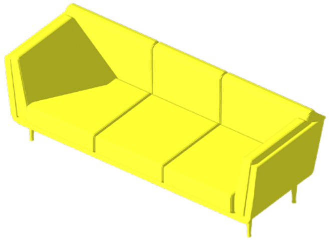
Floor lamp

Carpet

Wardrobe

# Flexible Furniture

## Sofa

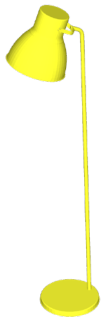


**Composition:**

| | |
|---|---|
| Wood | 0.16 $m^3$ |
| Linen | 0.7 $m^3$ |
| Foam | 0.27 $m^3$ |

**Life span:**

## Floor Lamp

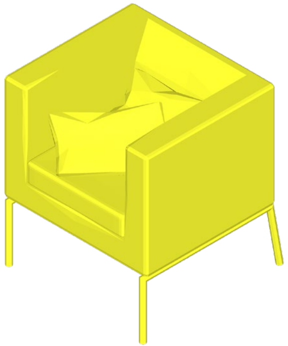


**Composition:**

| | |
|---|---|
| Stainless Steel | 0.000004 $m^3$ |
| Plastic | 0.00006 $m^3$ |
| Glass | 0.00006 $m^3$ |

**Life span:** 10 + years

## Arm Chair

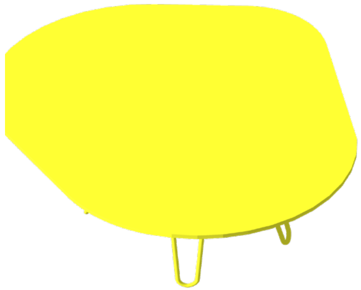


**Composition:**

| | |
|---|---|
| Wood | 0.026 $m^3$ |
| Linen | 0.2 $m^3$ |
| Foam | 0.06 $m^3$ |
| Aluminium | 0.0006 $m^3$ |

**Life span:** 10 years

## Coffee Table



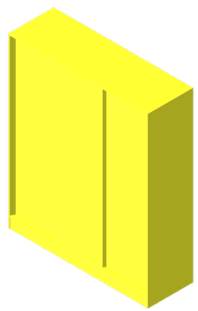
**Composition:**

| | |
|---|---|
| Wood | 0.205 $m^3$ |

**Life span:** 15 years

# Flexible Furniture

## Wardrobe

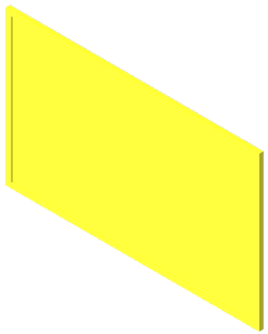


**Composition:**

| | |
|---|---|
| Wood | 0.17 $m^3$ |

**Life span:** 20 years

## TV

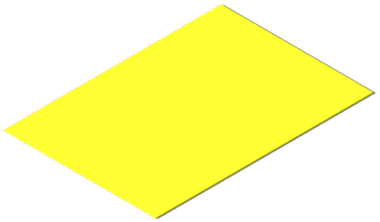


**Composition:**

| | |
|---|---|
| Stainless Steel | 0.0002$m^3$ |
| Plastic | 0.003$m^3$ |
| Glass | 0.0032$m^3$ |
| Aluminium | 0.001$m^3$ |

**Life span:** 10 years

## Carpet

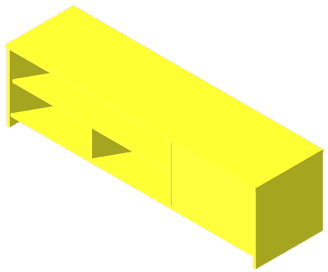


**Composition:**

| | |
|---|---|
| Fabric | 0.134$m^3$ |

**Life span:** 10 years

## TV Stand



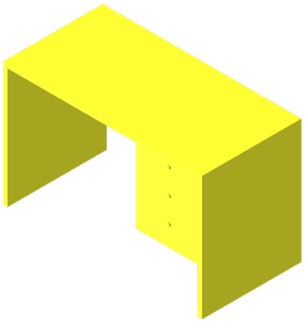
**Composition:**

| | |
|---|---|
| Wood | 0.05$m^3$ |

**Life span:** 20 years

# Flexible Furniture

## Desk

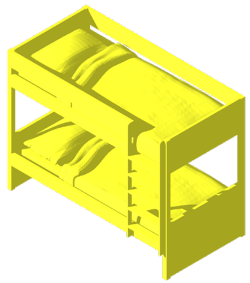


**Composition:**

| | |
|---|---|
| Wood | 0.16m$^3$ |
| Linen | 0.7m$^3$ |
| Foam | 0.27m$^3$ |

**Life span:** 15 years

## Double bed



**Composition:**

| | |
|---|---|
| Stainless Steel | 0.000004m$^3$ |
| Plastic | 0.00006m$^3$ |
| Glass | 0.00006m$^3$ |

**Life span:** 10 + years

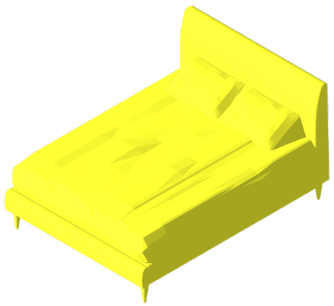
## Arm Chair

**Composition:**

| | |
|---|---|
| Wood | 0.026m$^3$ |
| Linen | 0.2m$^3$ |
| Foam | 0.06m$^3$ |
| Aluminium | 0.0006m$^3$ |

**Life span:** 10 years

## Single bed

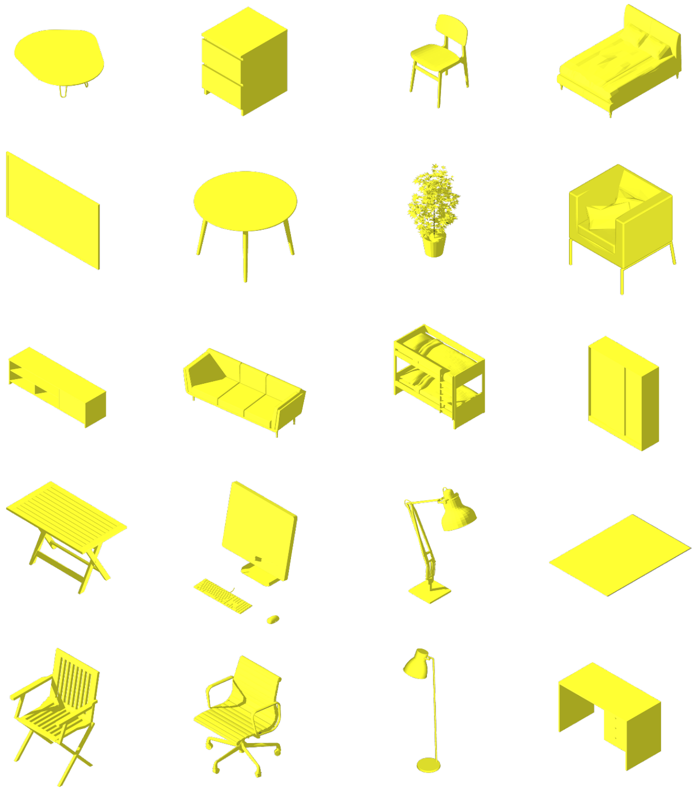


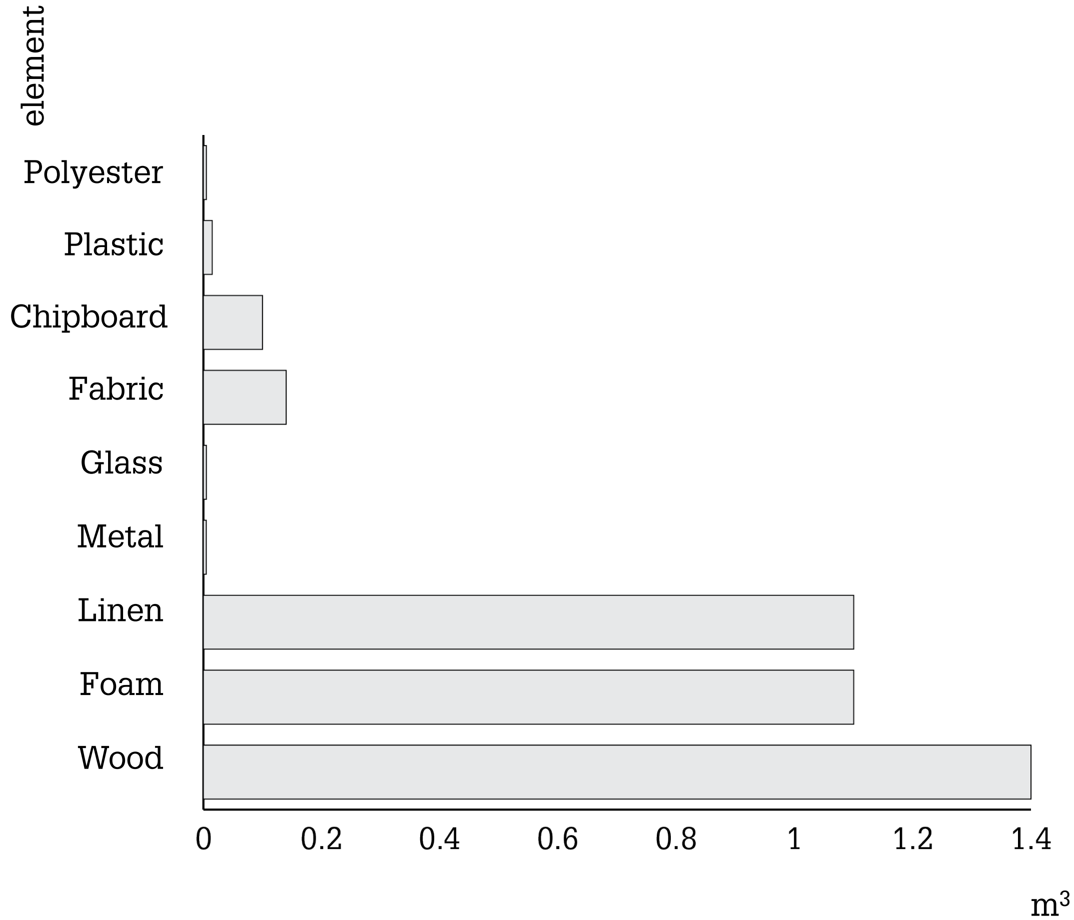
**Composition:**

| | |
|---|---|
| Wood | 0.205m$^3$ |

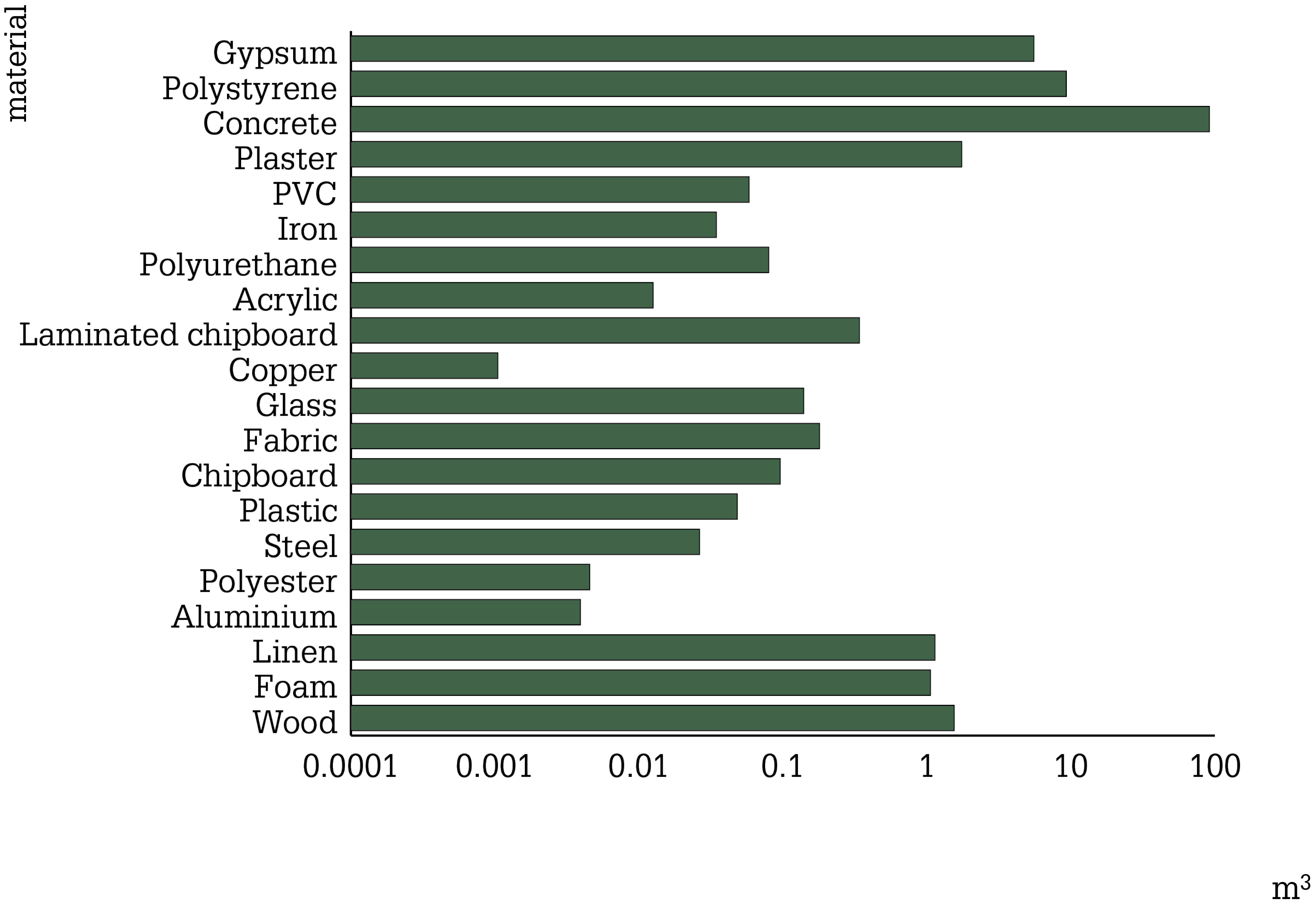
**Life span:** 10 + years

# Flexible Furniture

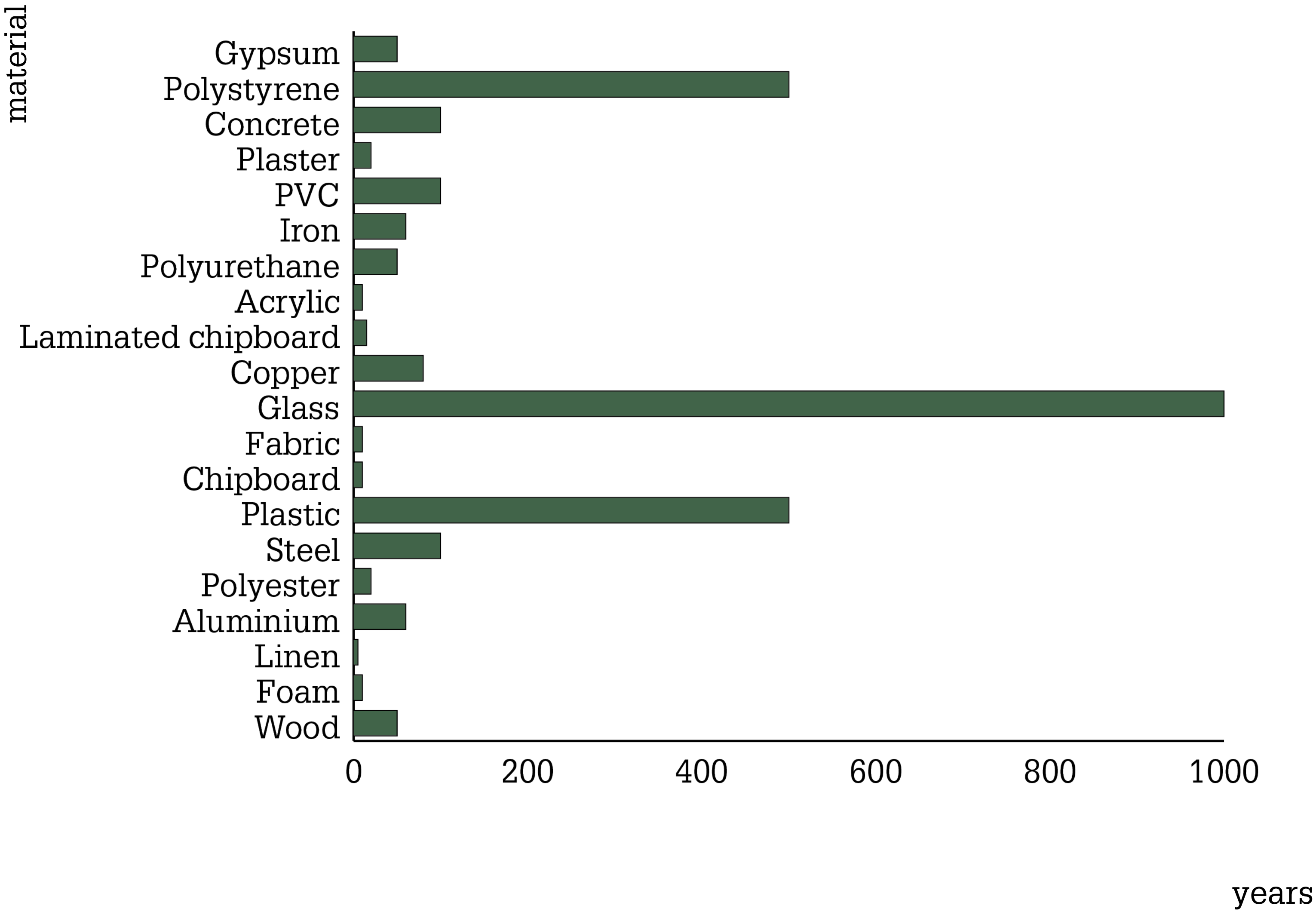




# Graph of the volumes of used materials in m³



# Life span of the materials



# HOW EFFICIENT ARE WE?

## Material efficiency of element

$$\frac{\text{Lifespan of element}}{\text{Lifespan of material}} = \text{\% Material efficiency}$$

# Material efficiency of items

- Wardrobe/Wood

**20 years**
**Usespan of an item**

**60 years**
**Lifespan of a material**

=

**33.3%**
**Material efficiency**

3.2 WHAT IS IT MADE OF

# Material efficiency of items

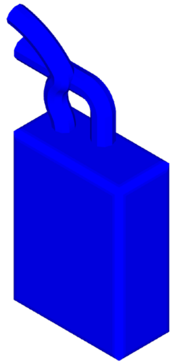
- Panel/Concrete

75 years
Usespan of element

100 years
Lifespan of material

**75%**
**Material Efficiency**

- Boiler/Steel

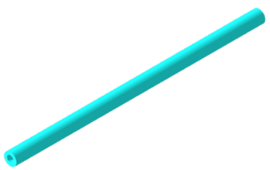


15 years
Usespan of element

100 years
Lifespan of material

**15%**
**Material Efficiency**

- Pipe insulation/Mineral wool

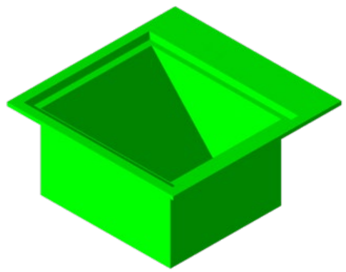


25 years
Usespan of element

80 years
Lifespan of material

**31.25%**
**Material Efficiency**

- Sink/Porcelain



20 years
Usespan of element

35 years
Lifespan of material

**57.1%**
**Material Efficiency**

## Material efficiency of a household

# 38.5%

## Average material efficiency of the Czech household

# 3.3
# HOW DO WE LIVE IN IT?

Knowing what is the average household made of, we will look at how people live in it. We will analyse 24 hours through differenet activities and their needs.

# 24 HOURS IN A HOUSE

## List of activities

# The day is made of ...

Sleeping

Waking up

Taking a shower or a bath

Changing clothes

Cooking

Eating

Cleaning

Doing sport

Leaving

Coming back

Watching TV

Doing homework

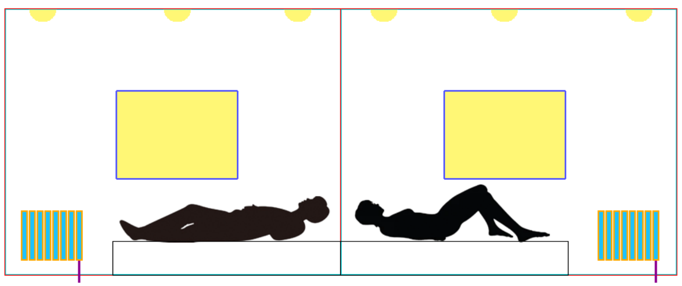
Receiving guest

...

# What do we need for each activity?

## Sleeping

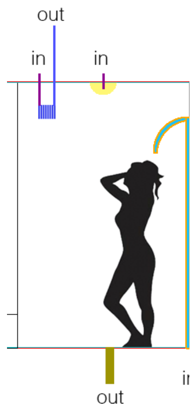
- Light
- Heat
- Air
- Water
- Waste
- Power



Oxygen, furniture, structure, heat, ventilation, sound insulation, thermal insulation

## Showering

- Light
- Heat
- Air
- Water
- Waste
- Power

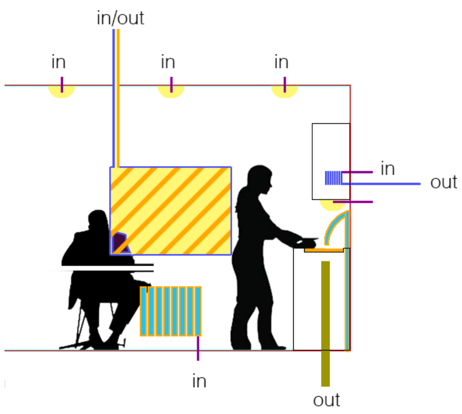



Oxygen, structure, heat, water, ventilation, light, thermal insulation,

# What do we need for each activity?

## Cooking breakfast

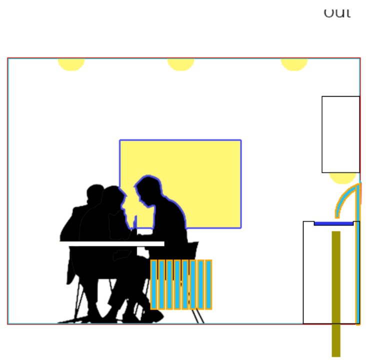
Light
Heat
Air
Water
Waste
Power




Oxygen, furniture, structure, heat, nutrition, water, transparency, ventilation, electricity, light, smell insulation, thermal insulation, waste

## Eating breakfast

Light
Heat
Air
Water
Waste
Power

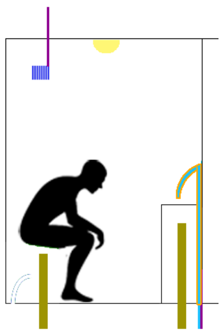


Oxygen, furniture, structure, heat, transparency, ventilation, light, smell insulation, thermal insulation, waste

# What do we need for each activity?

## Using toilet

Light
Heat
Air
Water
Waste
Power



Oxygen, furniture, structure, heat, water, ventilation, smell insulation, sound insulation, thermal insulation, waste

## Preparing to leave

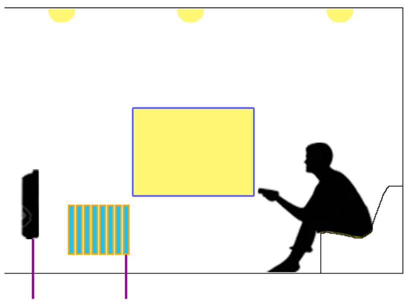
Light
Heat
Air
Water
Waste
Power

Oxygen, furniture, structure, light, thermal insulation

# What do we need for each activity?

## Free-time activity

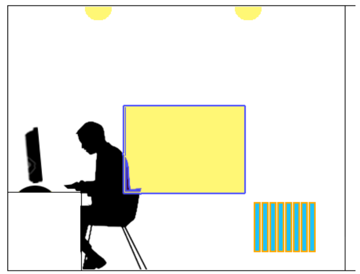
- Light
- Heat
- Air
- Water
- Waste
- Power



Oxygen, furniture, structure, heat, transparency, ventilation, electricity, light, sound insulation, thermal insulation

## Doing homework

- Light
- Heat
- Air
- Water
- Waste
- Power

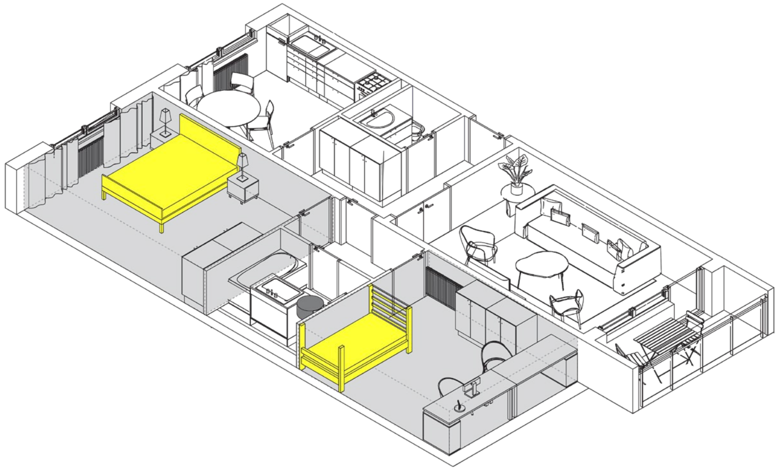


Oxygen, furniture, structure, heat, transparency, ventilation, electricity, light, sound insulation, thermal insulation

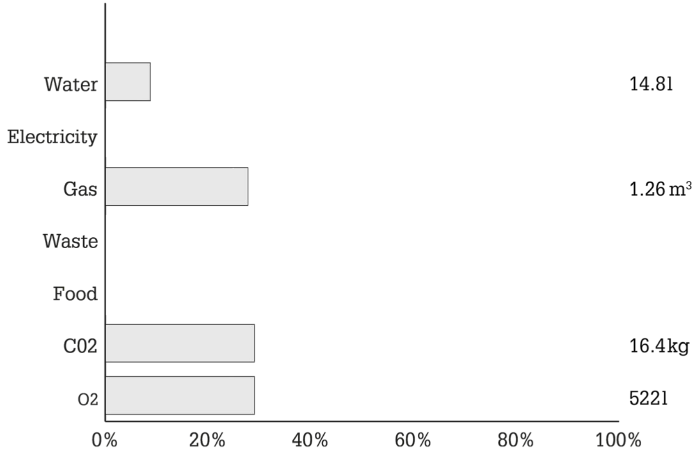
# CONSUMPTION OF A HOUSEHOLD IN 24 HOURS

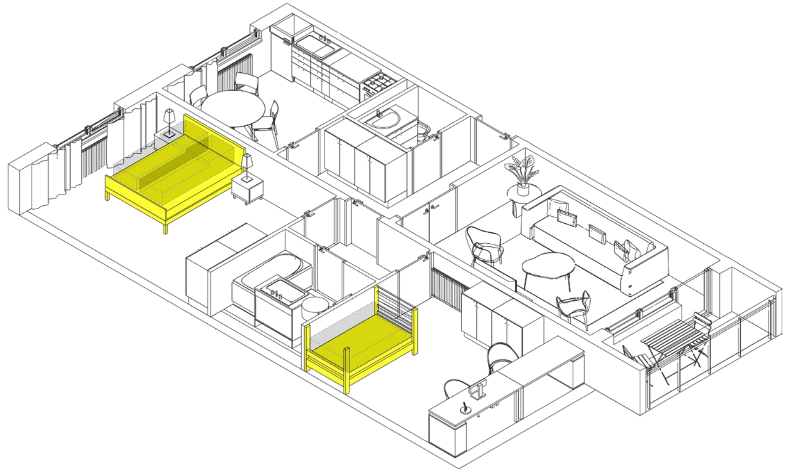
## How do we live

## What do we need

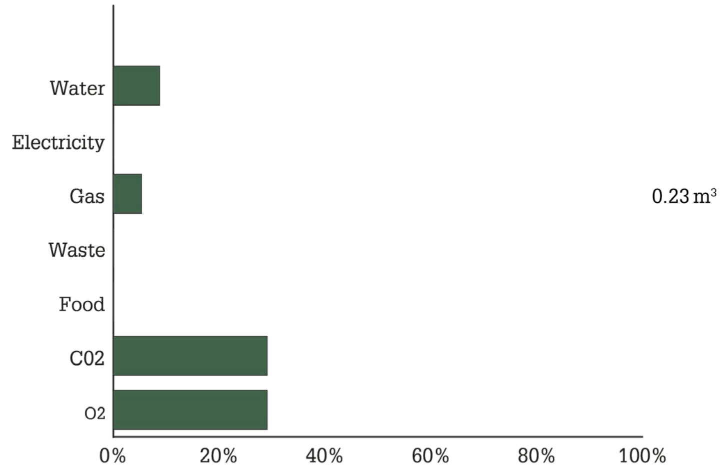


# 77.9m³

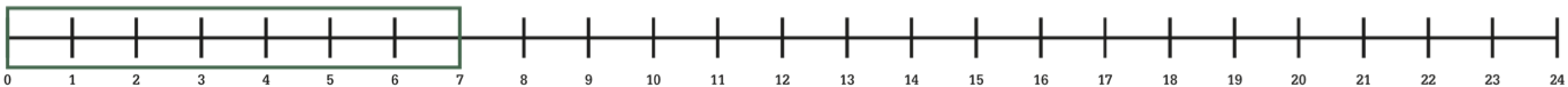


# 6.0m³

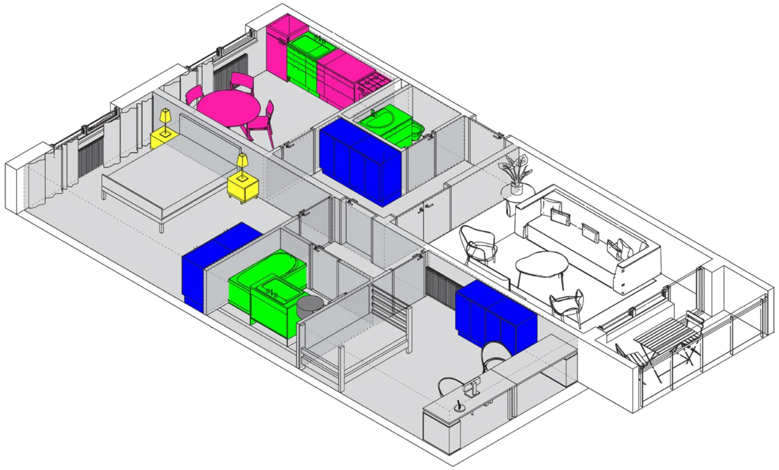



Timeline

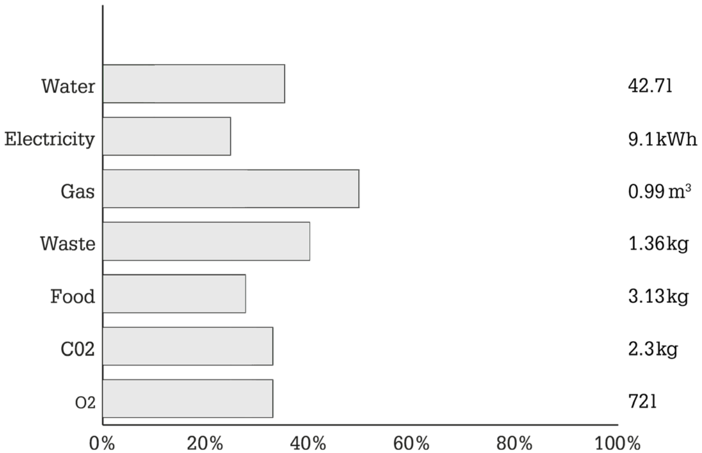


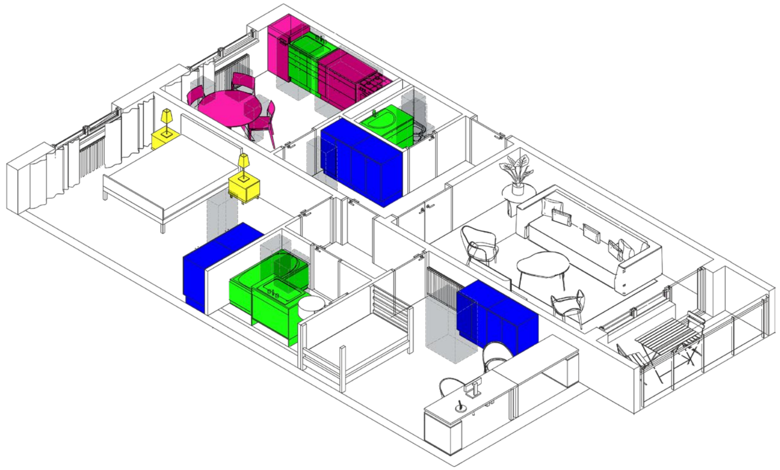
## How do we live

## What do we need

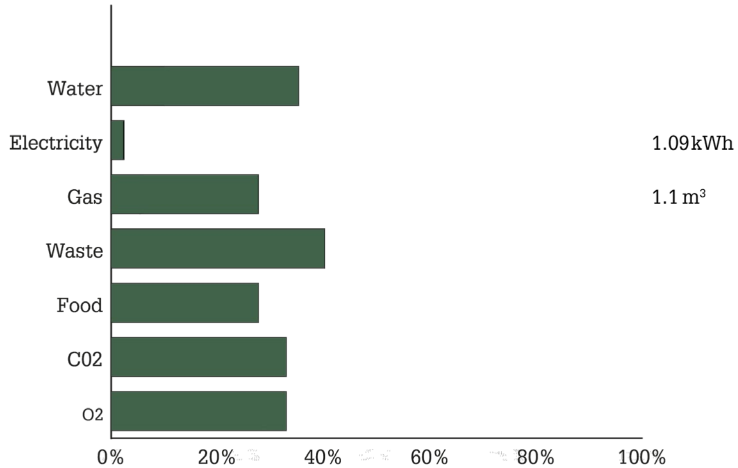


# 158.8m³

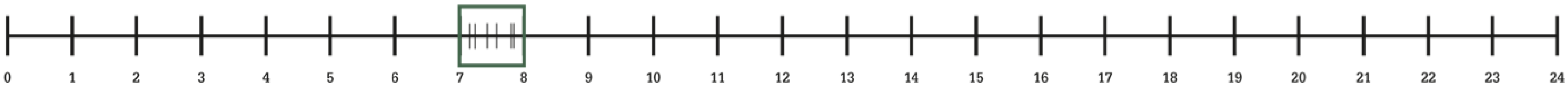


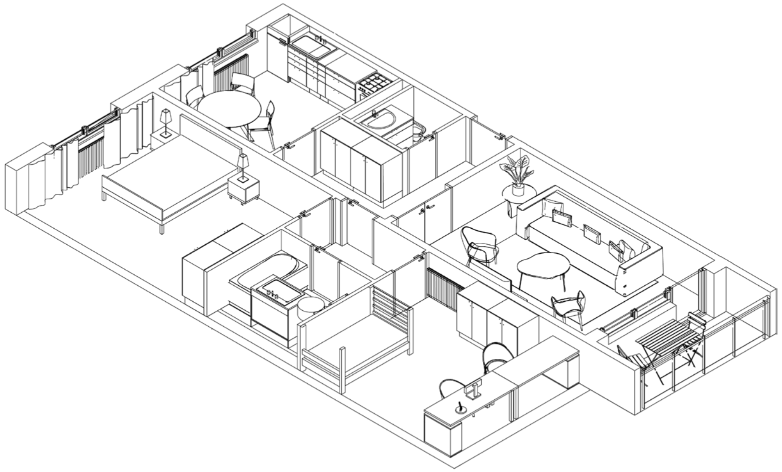
# 14.4m³



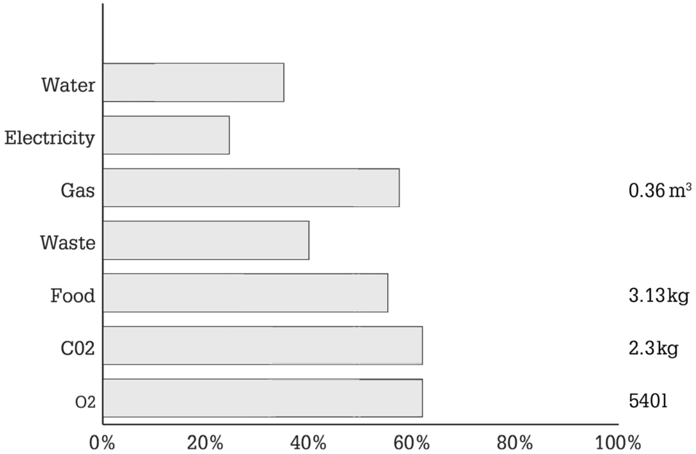

Timeline



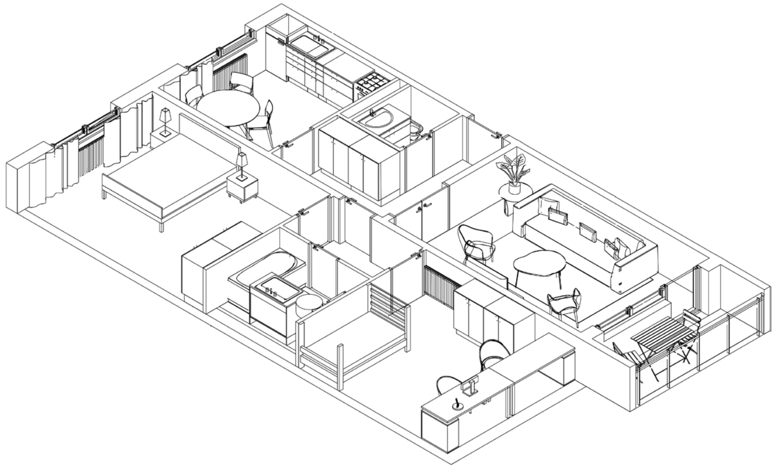
## How do we live



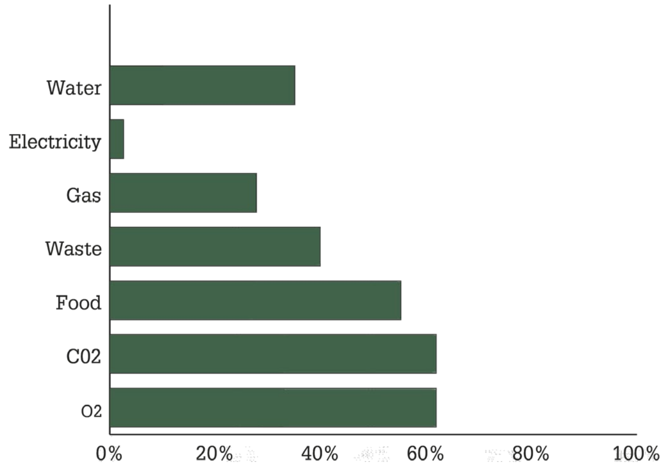
# 0m³



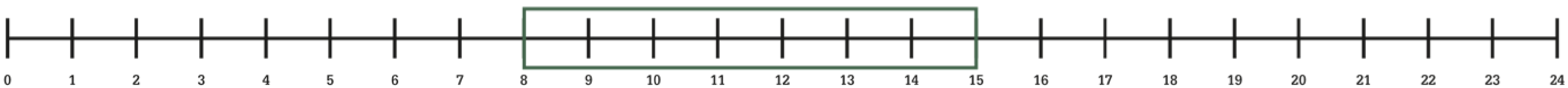

## What do we need



# 0m³

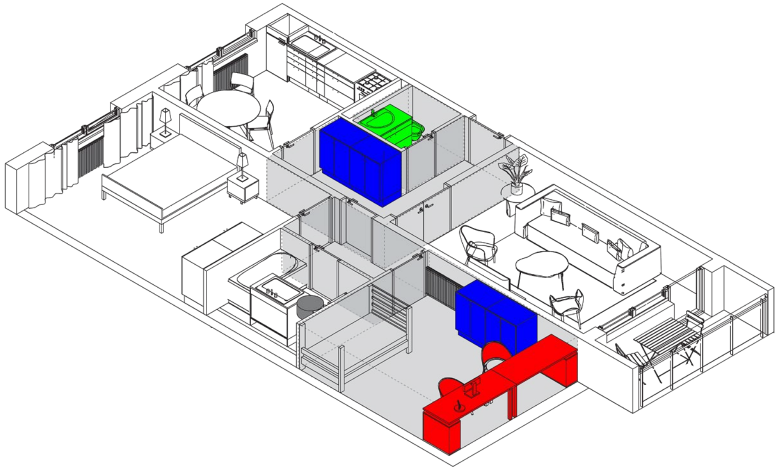


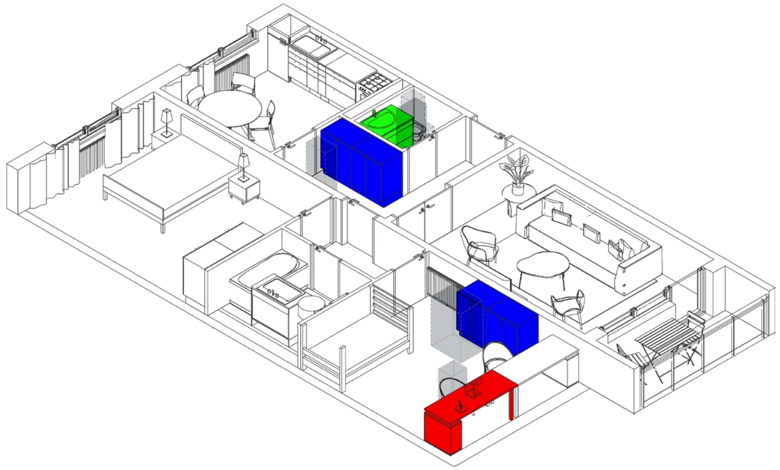

Timeline



## How do we live

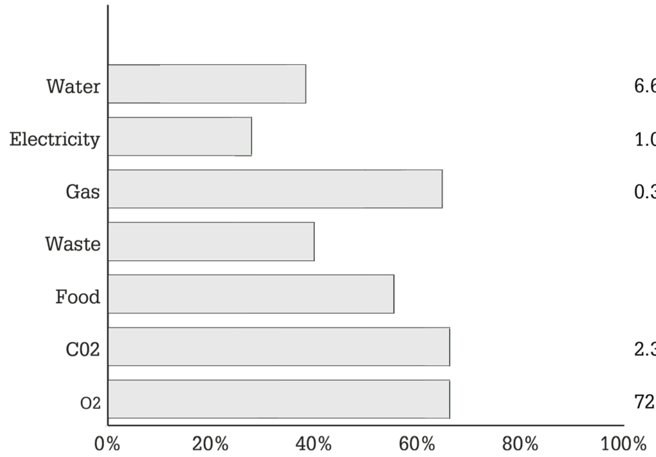
## What do we need

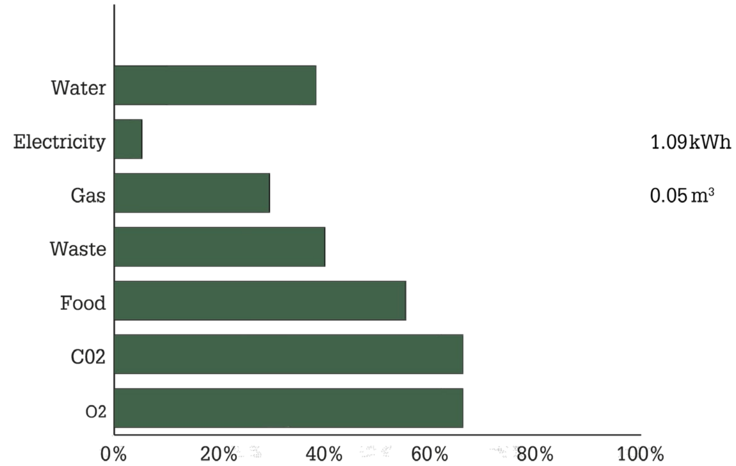




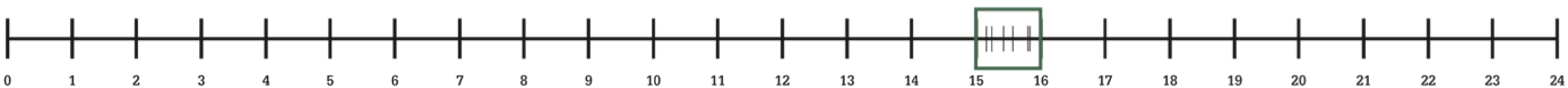
# 53.1m³

# 6.3m³



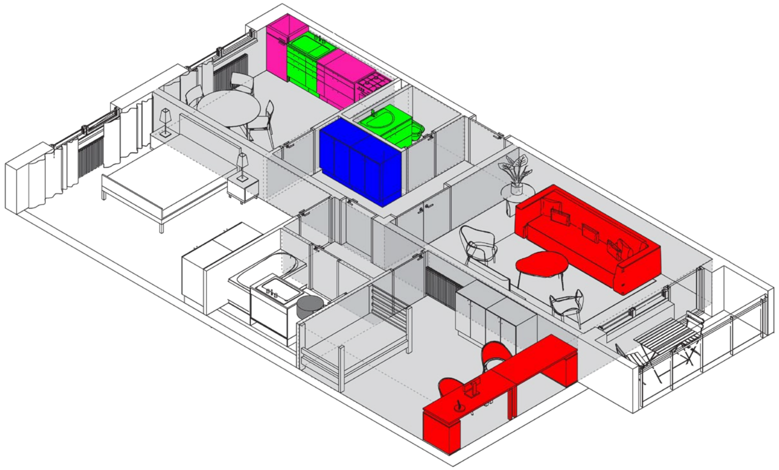



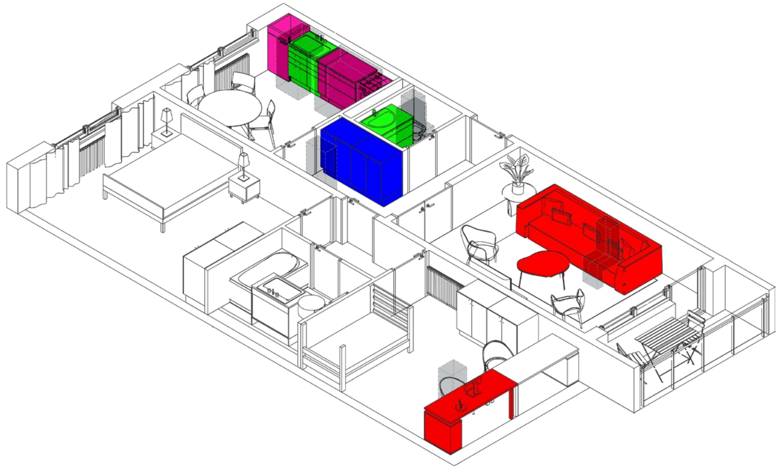

Timeline



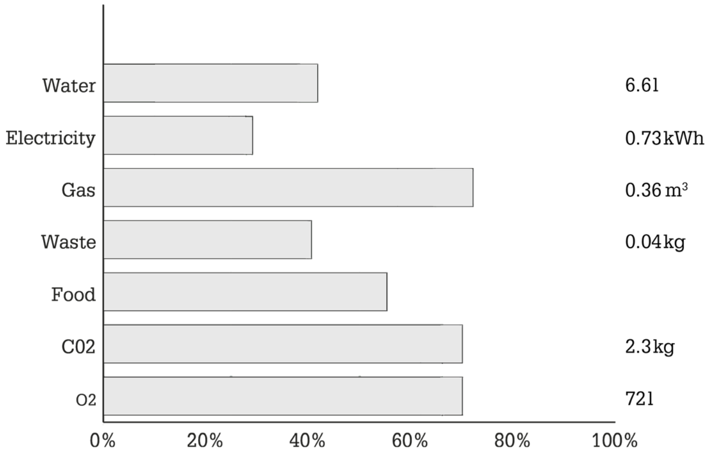
## How do we live

## What do we need

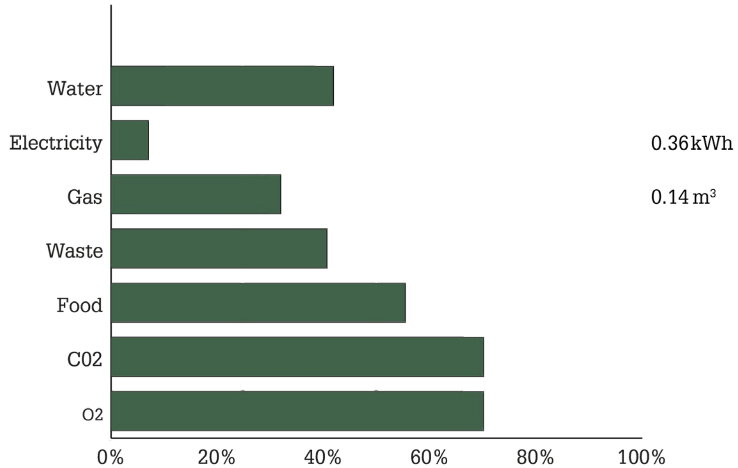




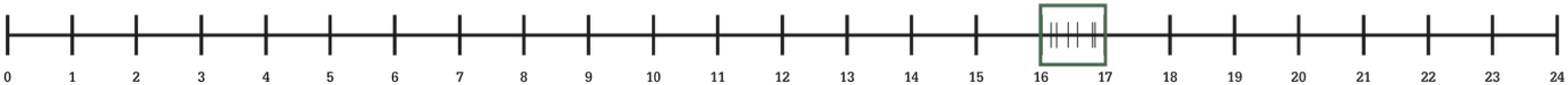
# 131.2m$^3$



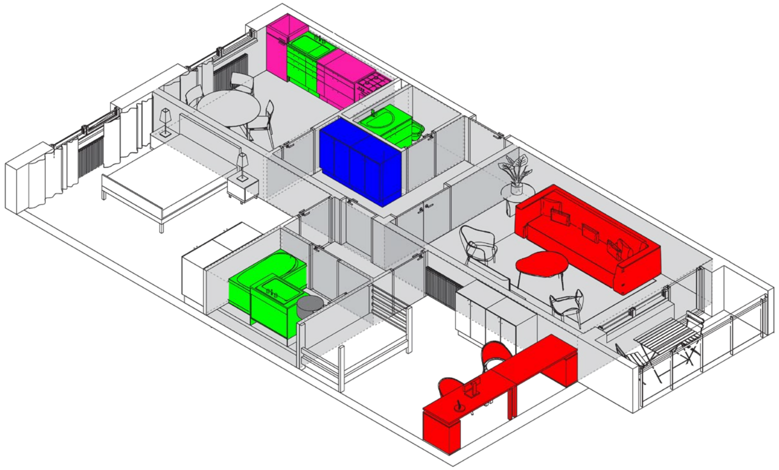

# 13.0m$^3$



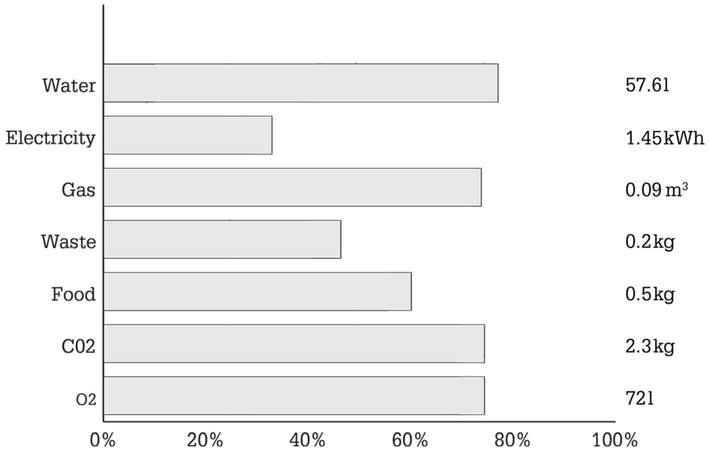

Timeline



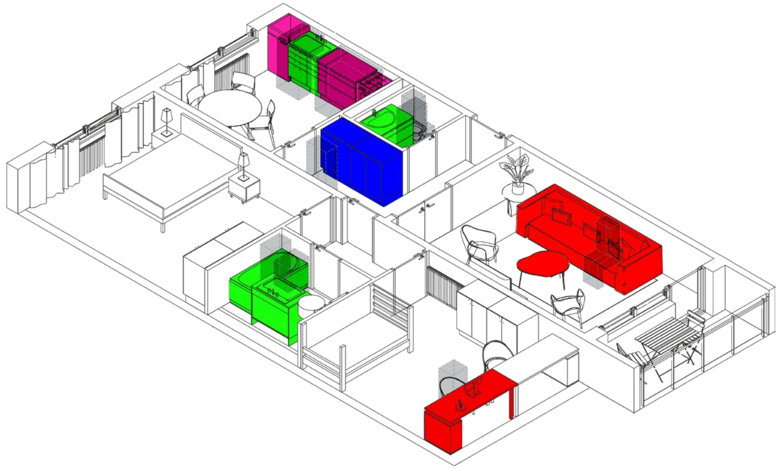
## How do we live



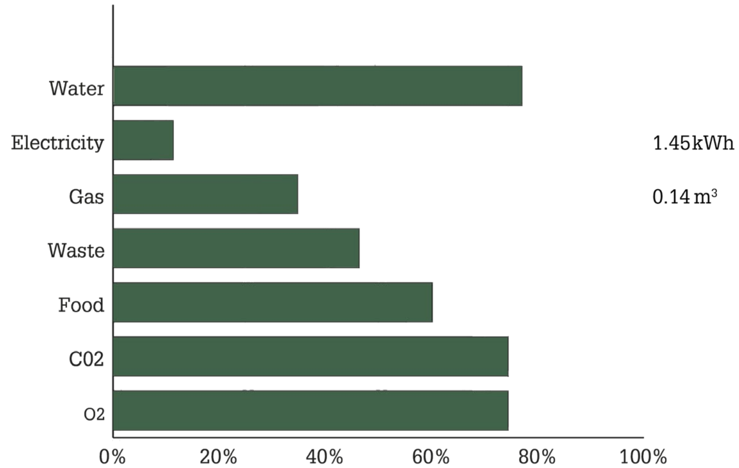
# 124.6m$^3$



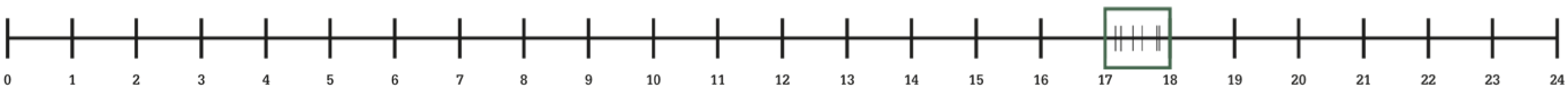

## What do we need



# 16.2m$^3$

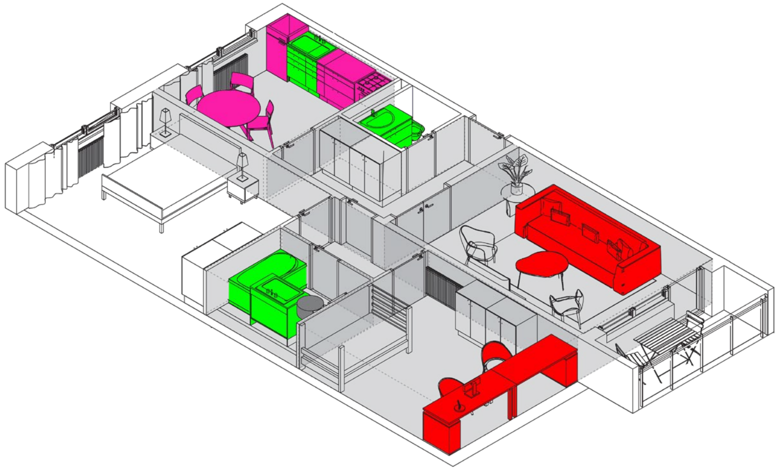


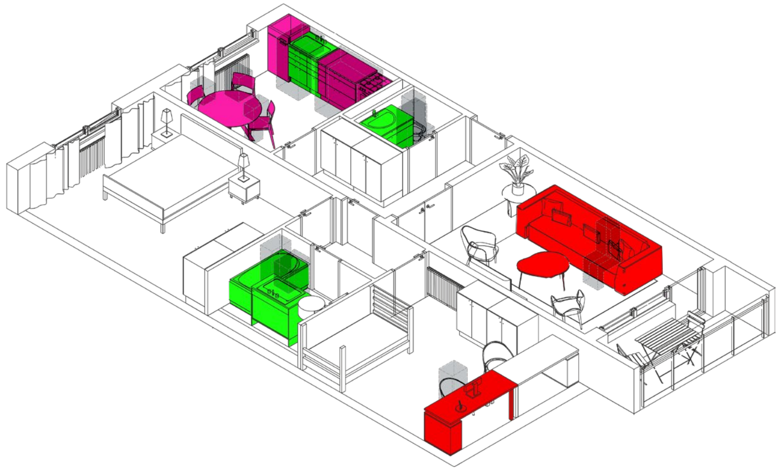

Timeline



## How do we live

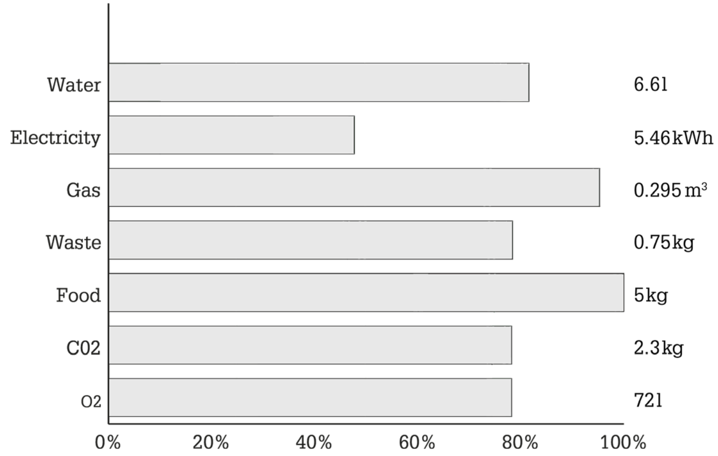
## What do we need

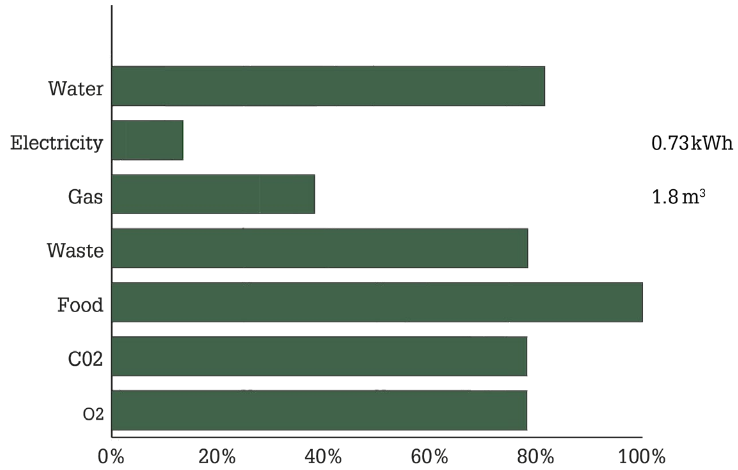




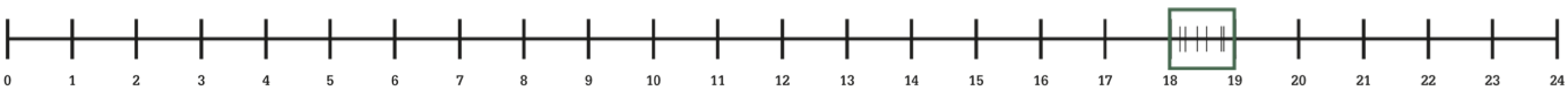
# 136.9m$^3$

# 17.2m$^3$



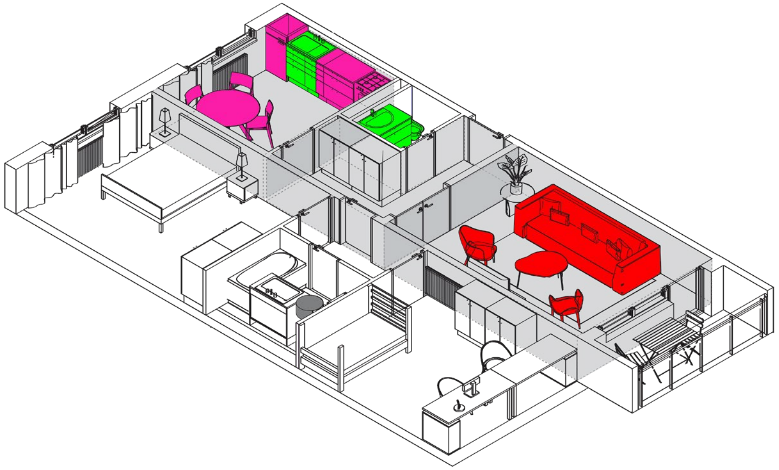



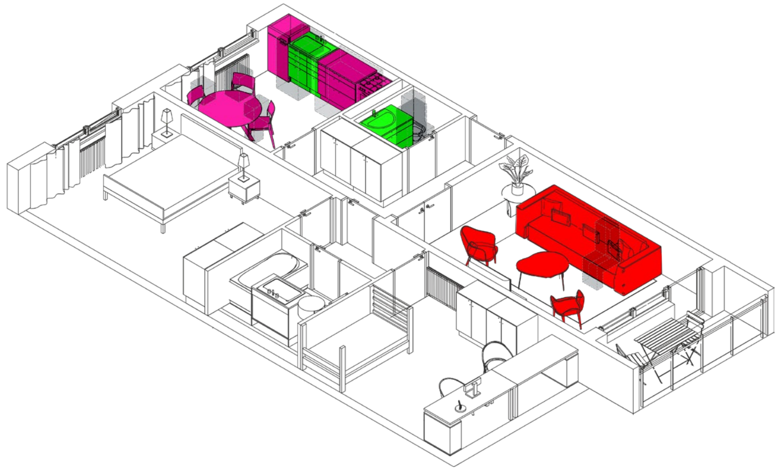

Timeline



## How do we live

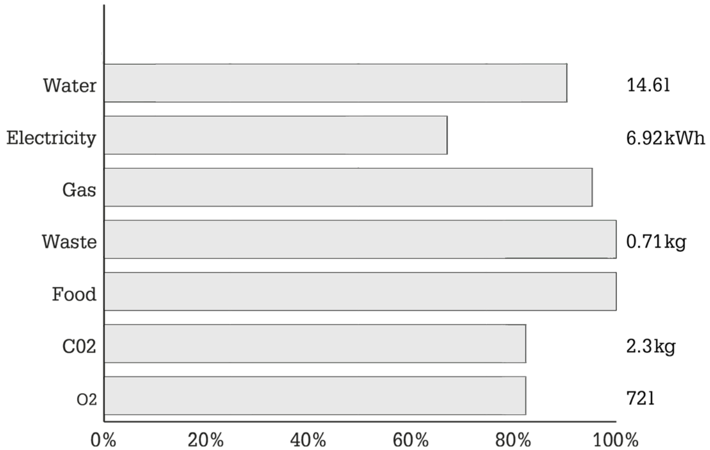
## What do we need

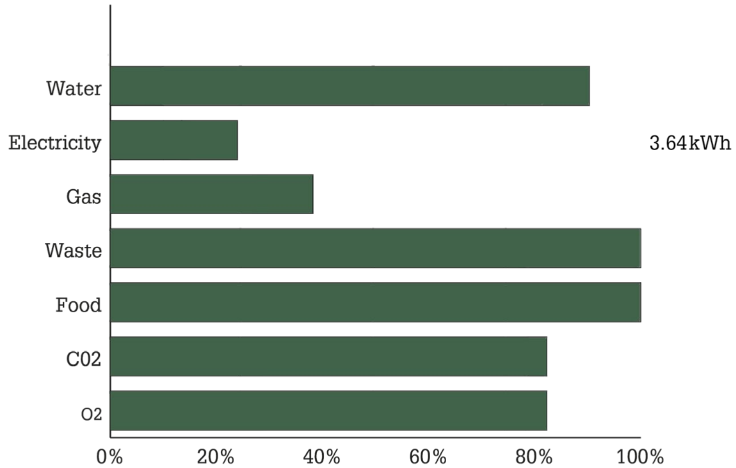




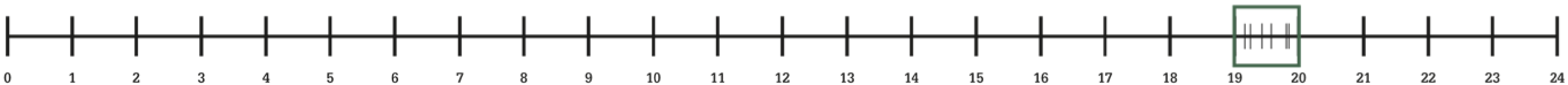
# $98.8m^3$

# $14.2m^3$



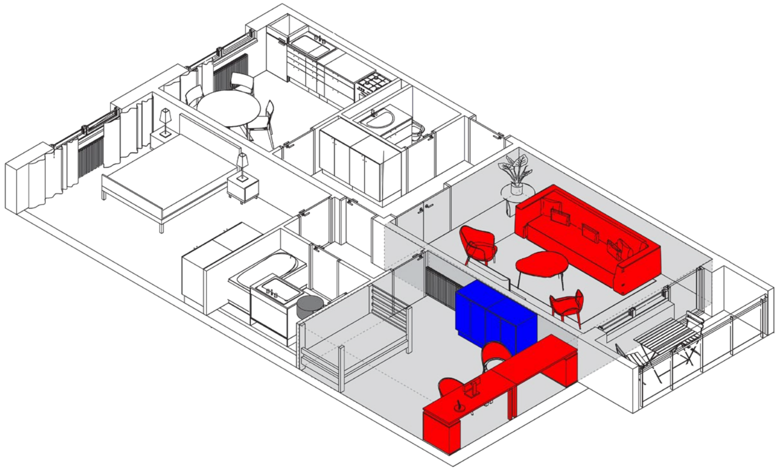



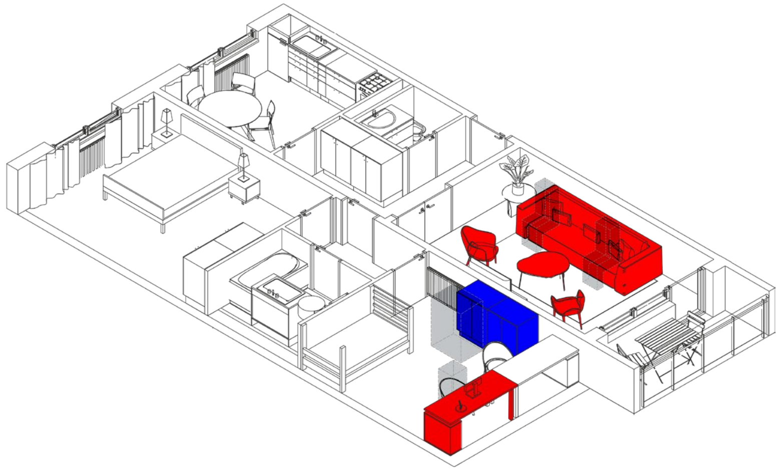

Timeline



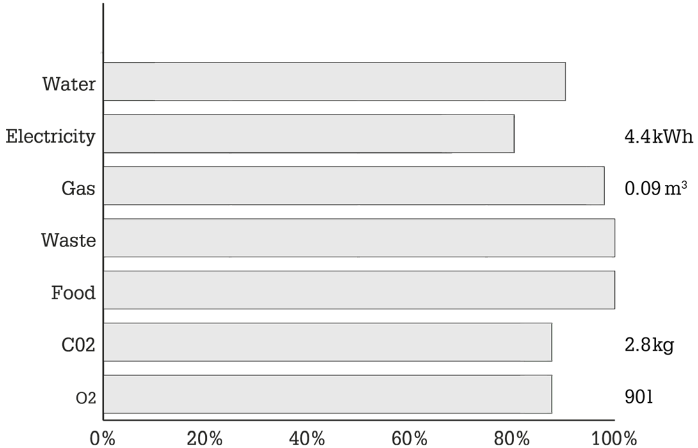
## How do we live

## What do we need

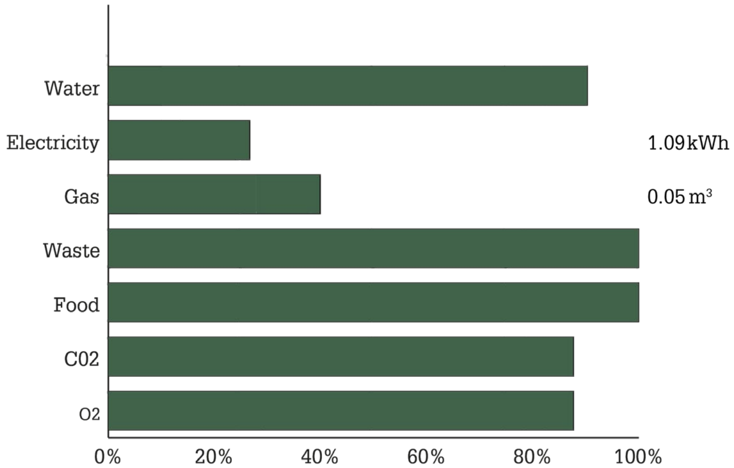




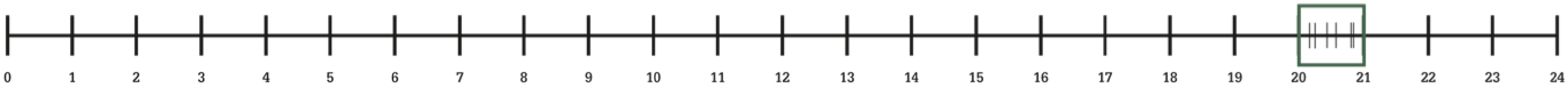
# 87.8m³



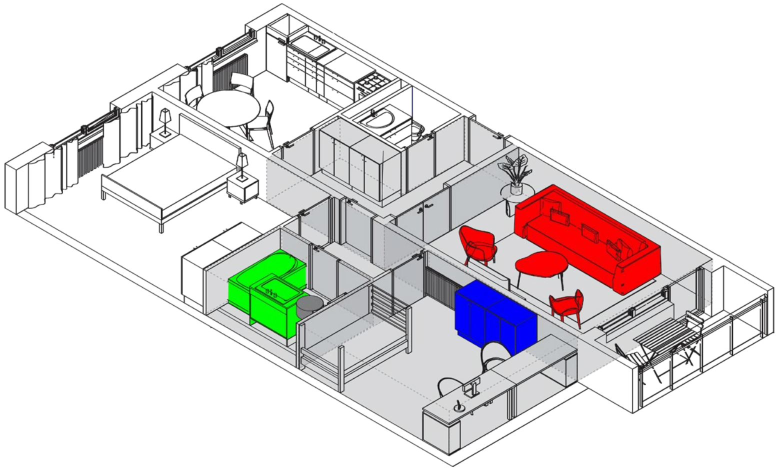

# 6.2m³



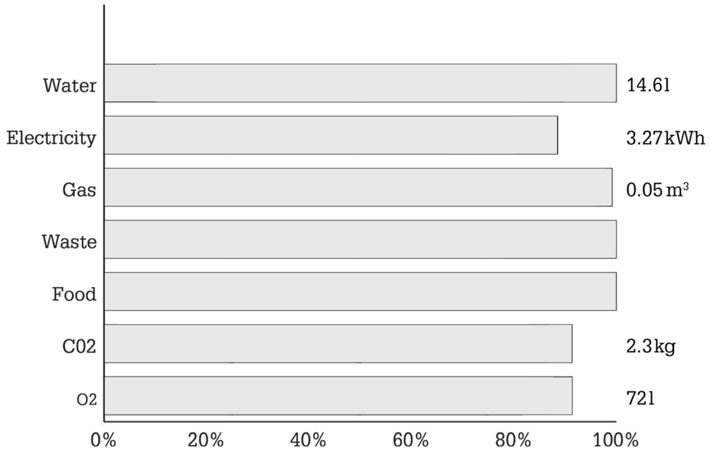

Timeline



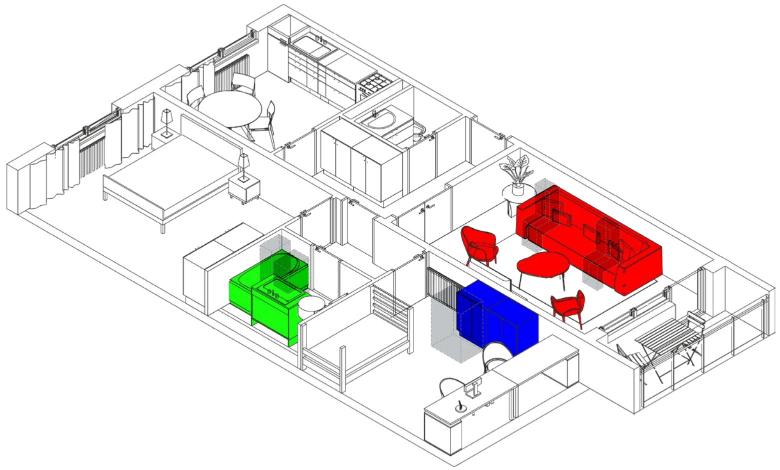
## How do we live



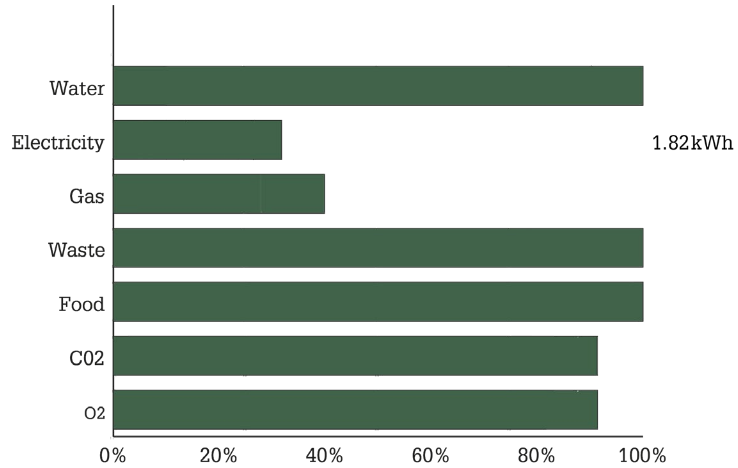
# 128.5$m^3$



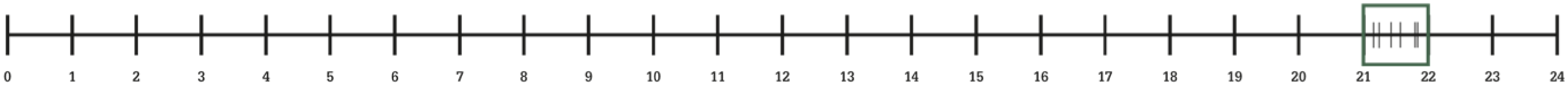

## What do we need



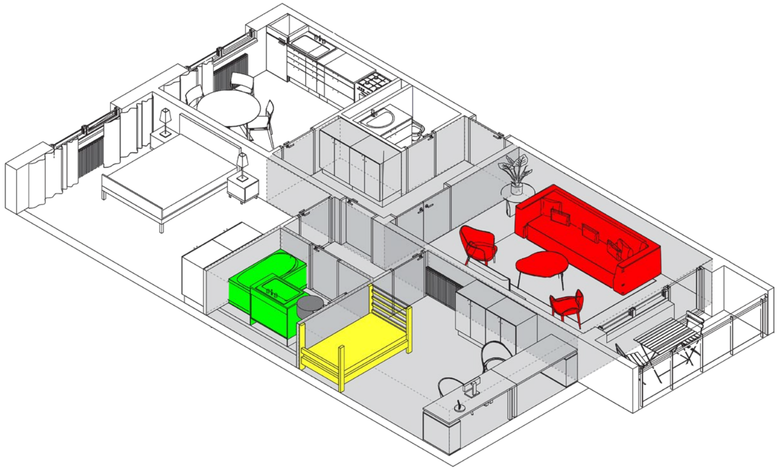
# 8.6$m^3$



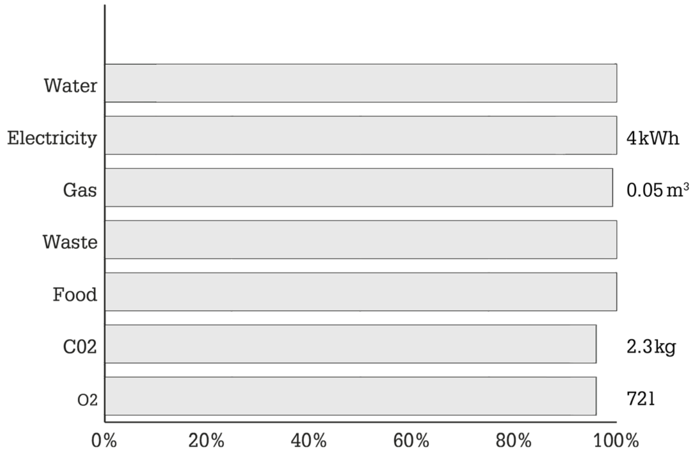

Timeline



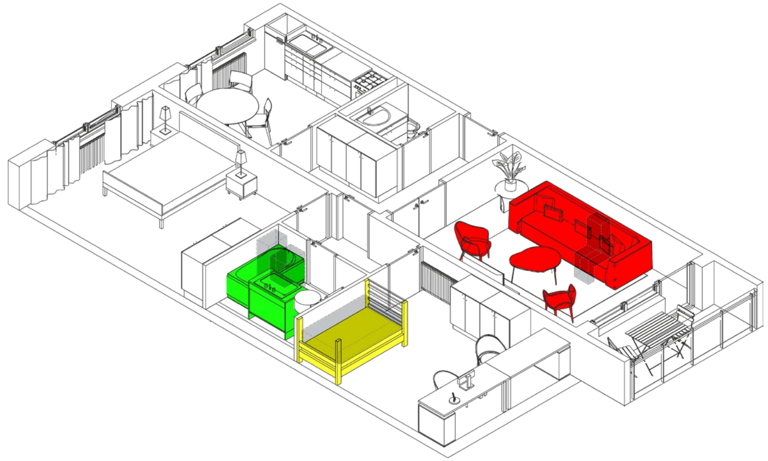
## How do we live



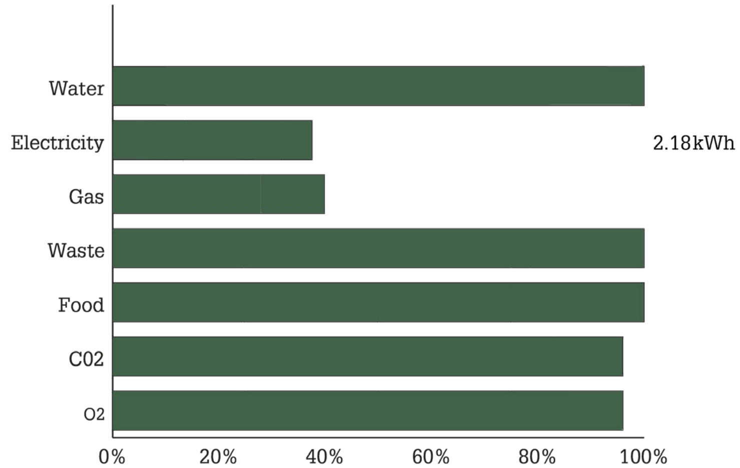
# 107.8m³



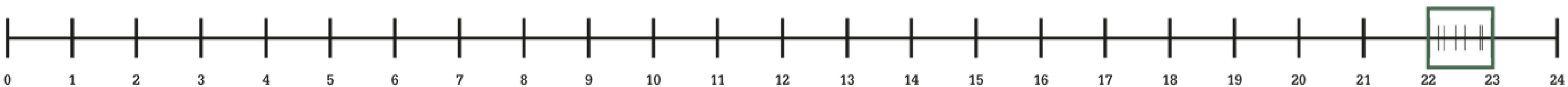

## What do we need



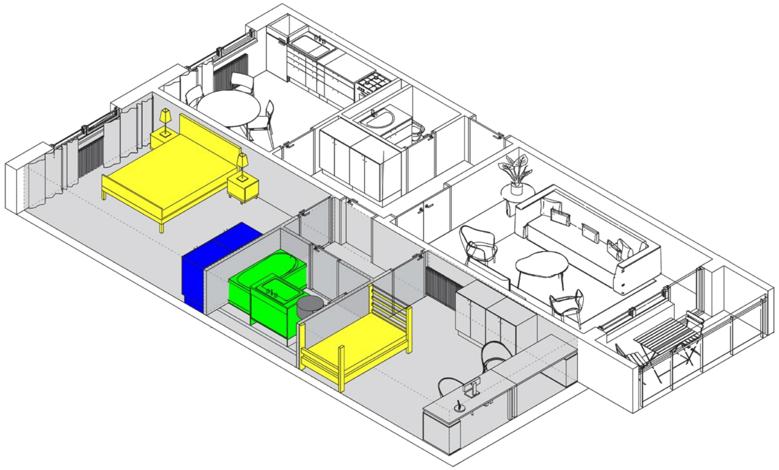
# 11.0m³



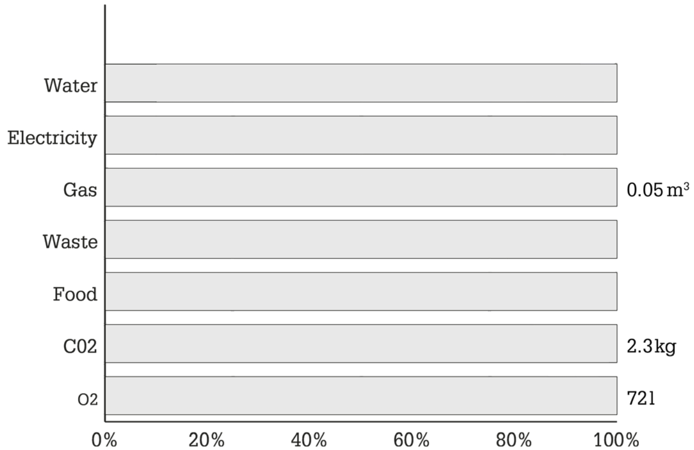

### Timeline



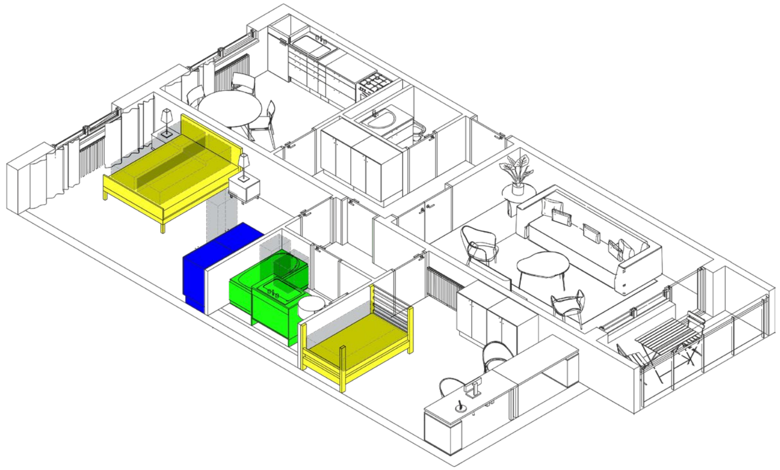
## How do we live



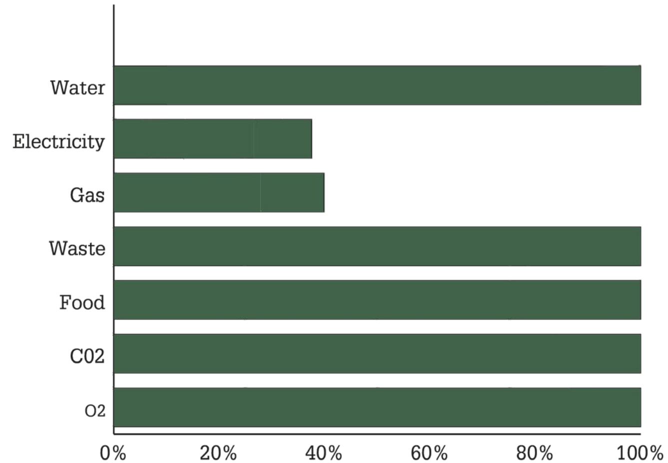
# 103.8m$^3$



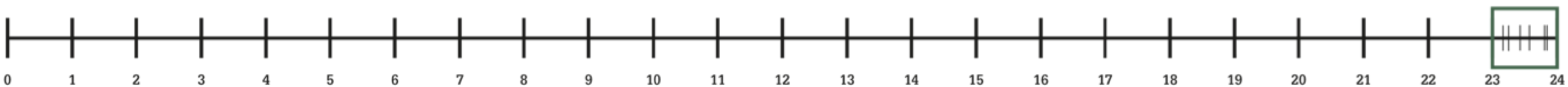

## What do we need



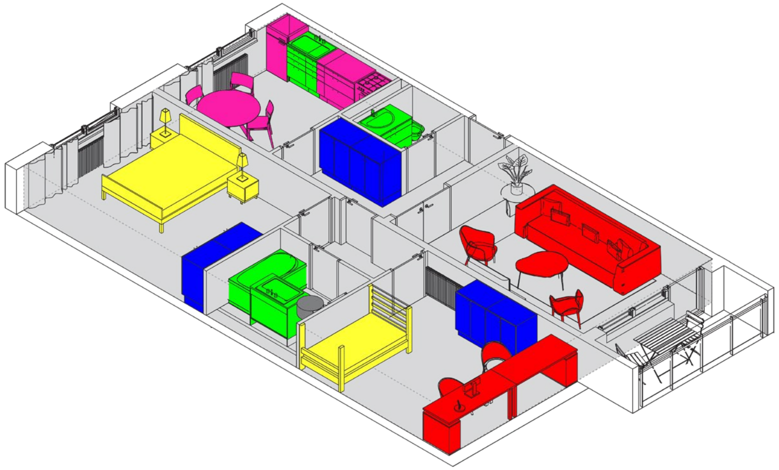
# 10.4m$^3$



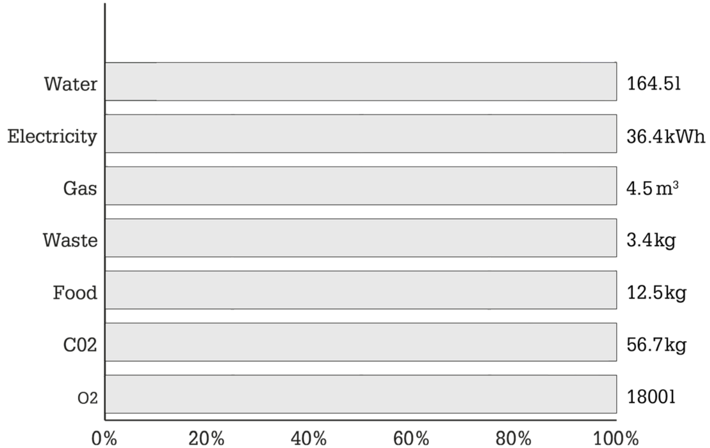

Timeline



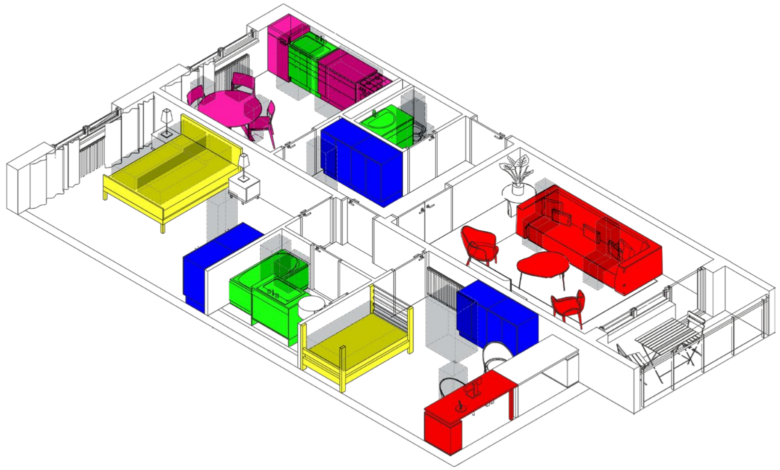
## How do we live



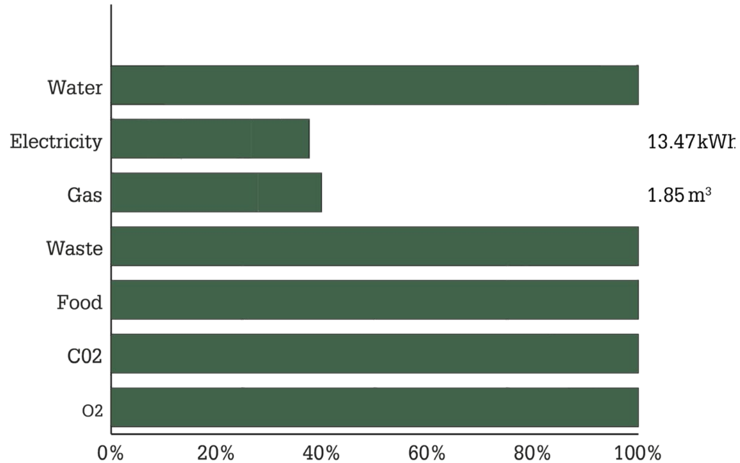
# $195.9m^3$



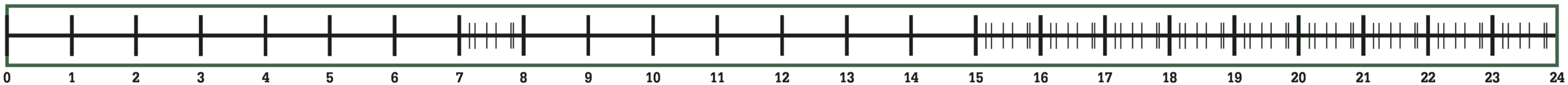

## What do we need



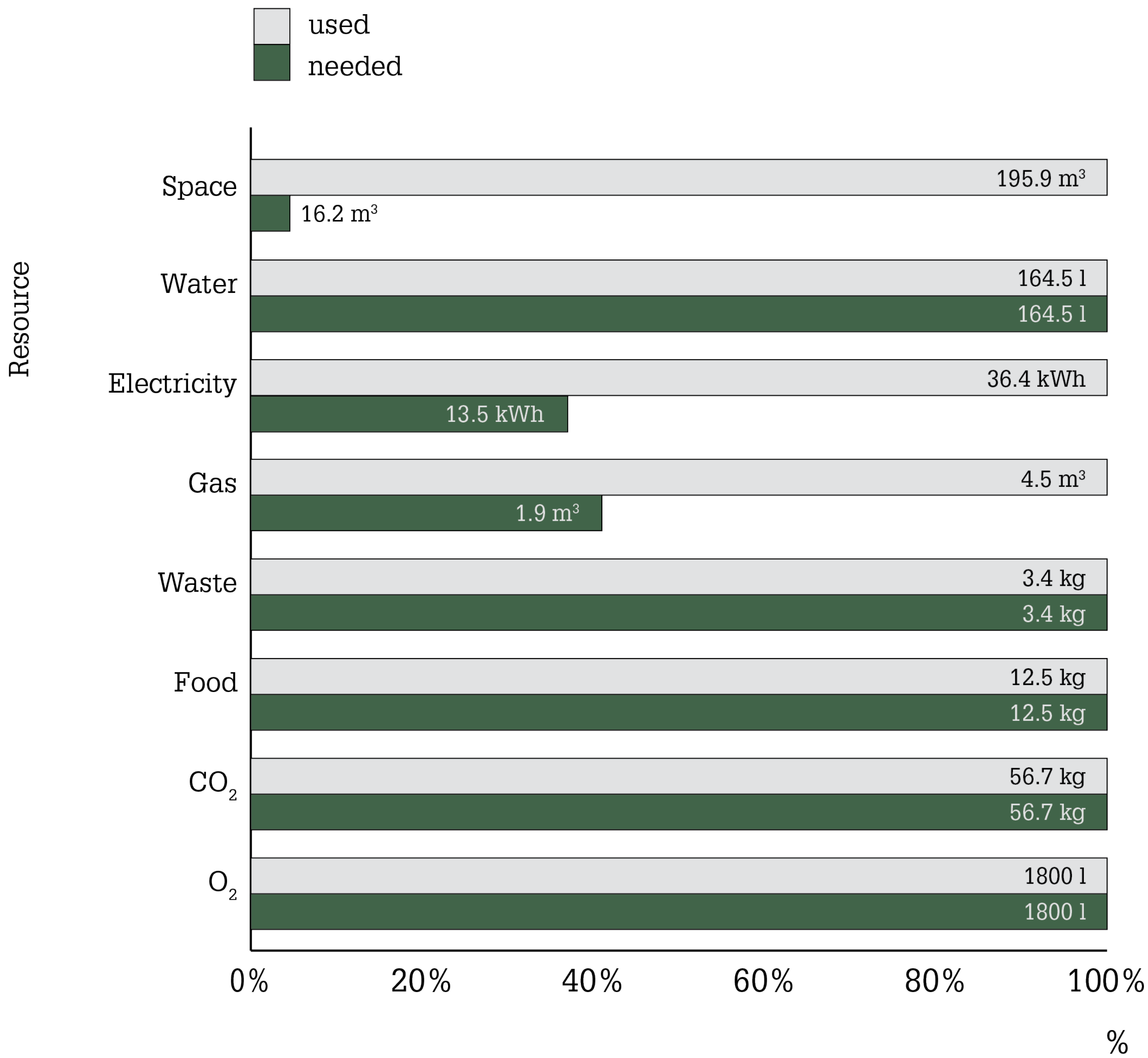
# $16.2m^3$



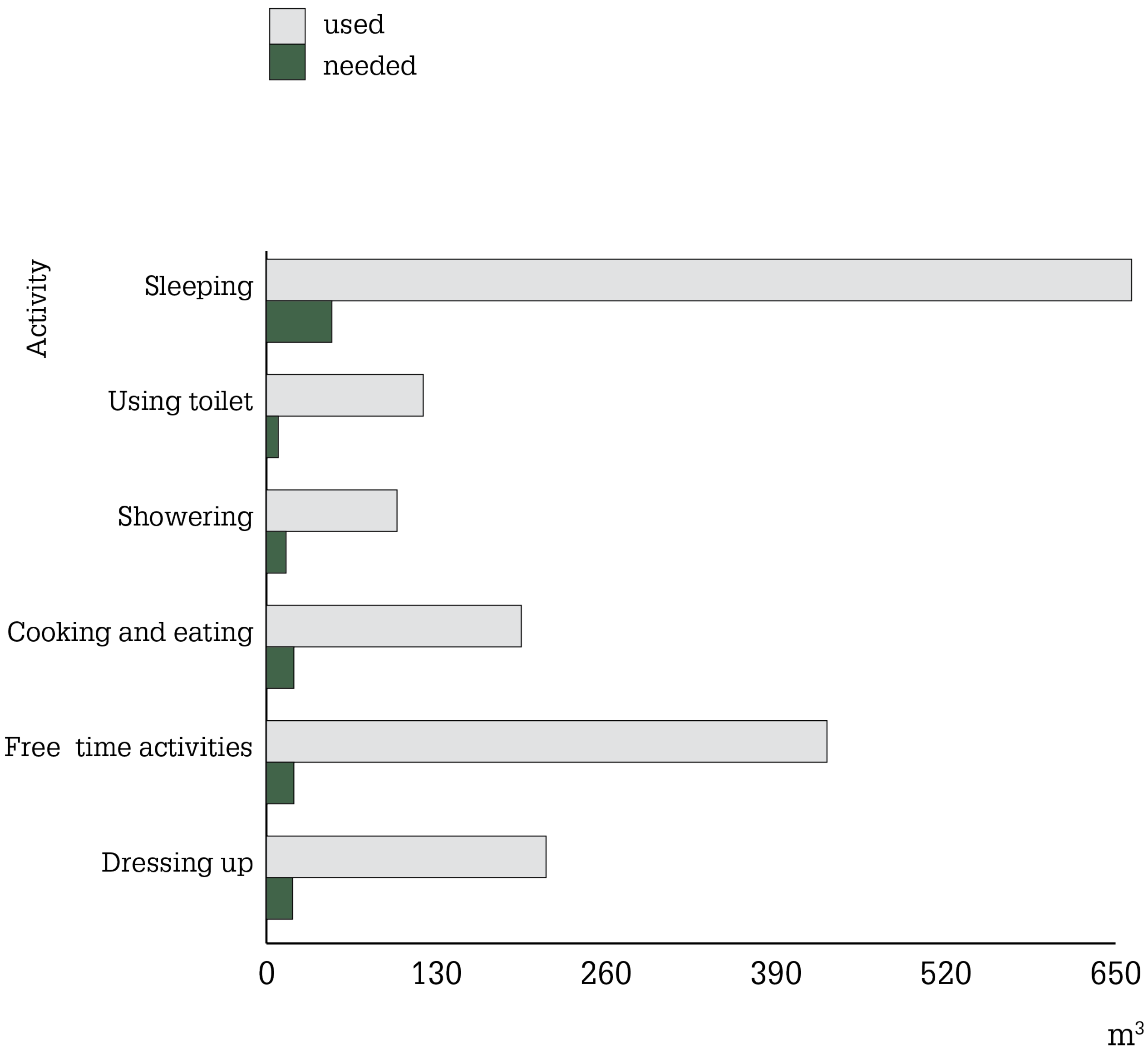

Timeline



# Comparison of used & needed resources



# Comparison of used & needed space



# WHAT IS THE CURRENT SPACE EFFICIENCY?

## Space efficiency of a household

$$\frac{\underset{\text{Space we need}}{16.2\ m^3}}{\underset{\text{Space we use}}{195.9\ m^3}} = \underset{\text{Household space efficiency}}{8.2\ \%}$$

**Analysing the average Czech household we learn that space reduction would be one way to limit the demands from the biocapacity.**

# 4

# WHAT IS OUR IMPACT?

What is measured

# What is the common unit?

**water**
liters

**electricity**
kWh

**food**
kg

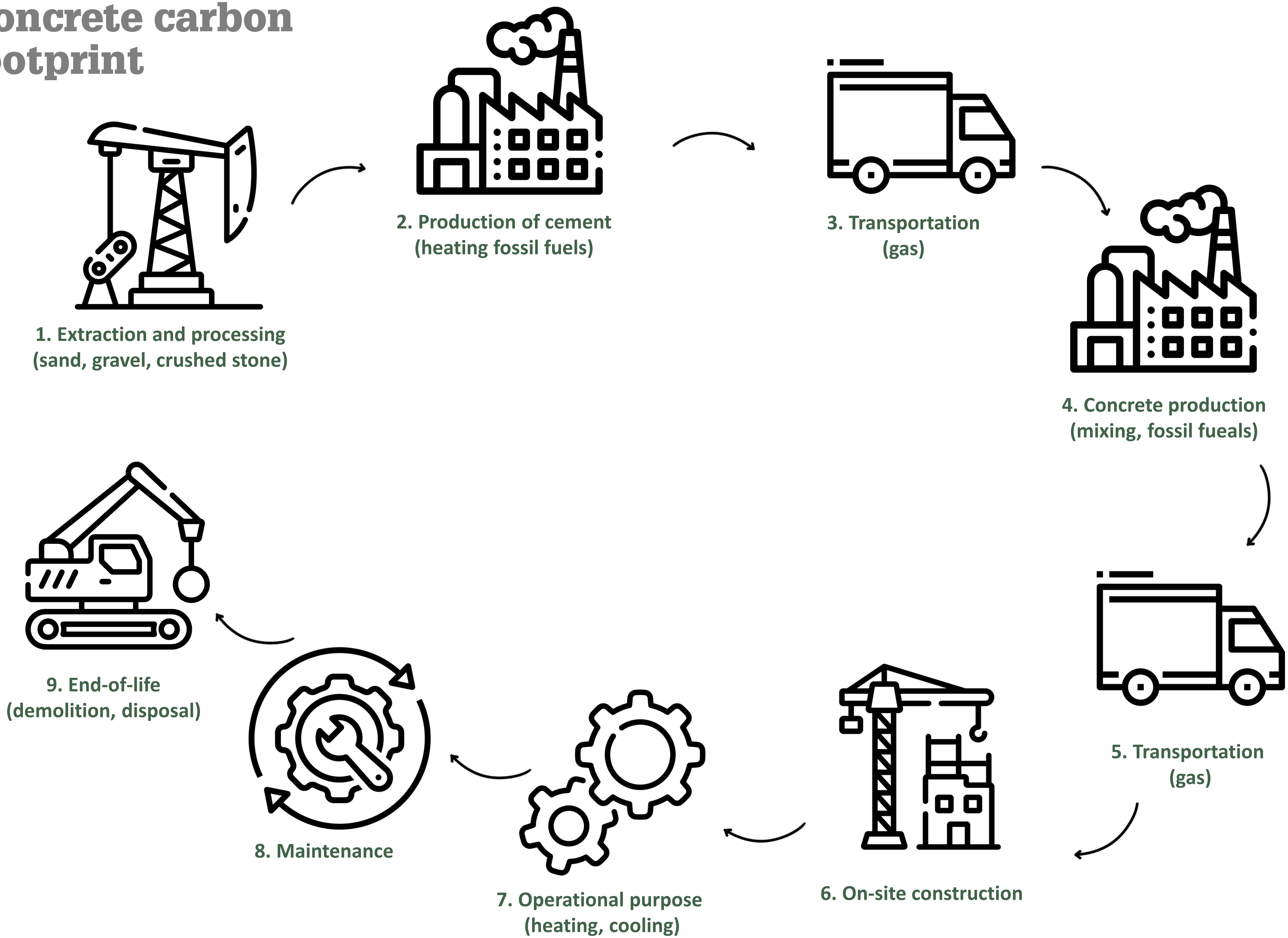
**waste**
kg

**$CO_2$**
kg

**gas**
$m^3$

**$O_2$**
kg

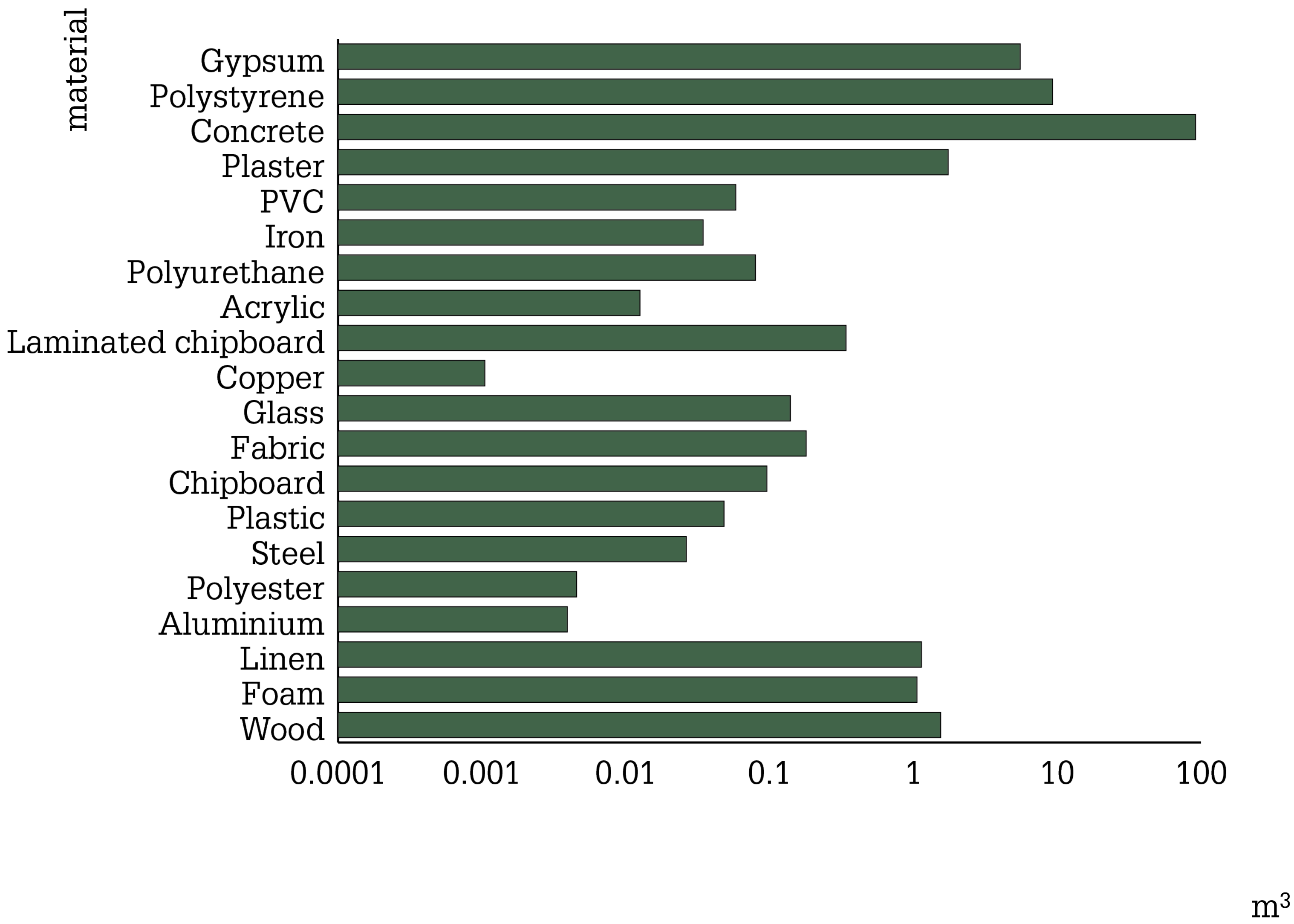
# Concrete carbon footprint



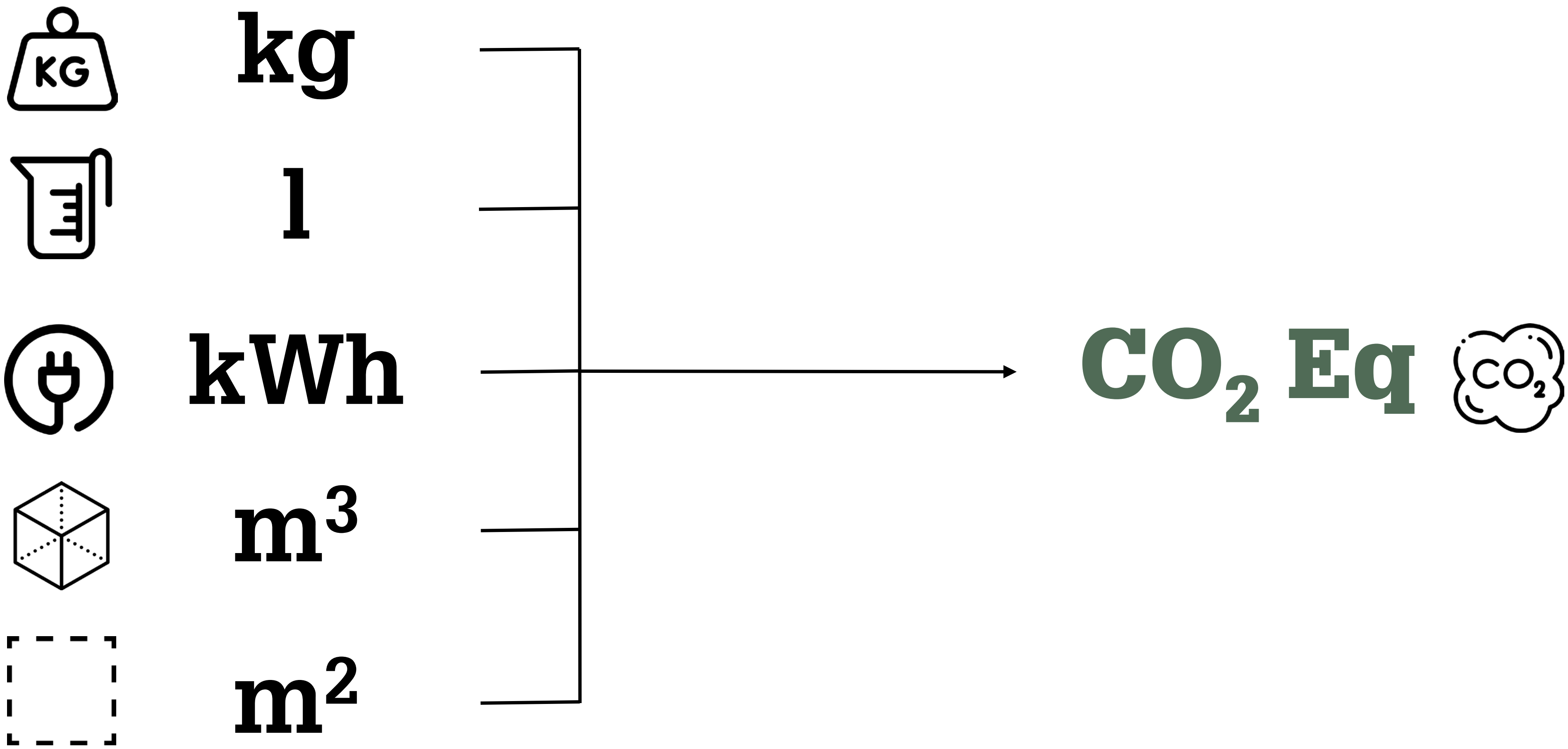
# Operational consumption of a household per 1 day

| | |
|---|---|
| Water | 164.5 l |
| Electricity | 36.4 kWh |
| Gas | 4.5 $m^3$ |
| Waste | 3.4 kg |
| Food | 12.5 kg |
| $CO_2$ | 56.7 kg |
| $O_2$ | 1800 l |

# Graph of the amount of used materials in $m^3$



## What is the common unit?



# Exampe of conversion

**Concrete used in one household**

**$CO_{2\ eq.}$ produced**
**(Including transport and other used resources)**

**17 650 kg** → **14 296 kg**

# Conversion

## Operational $CO_2$ equivalent

| | |
|---|---|
| Water | **49 kg** |
| Electricity | **8.55 kg** |
| Gas | **13.47 kg** |
| | **...** |

## Embodied $CO_2$ equivalent

| | |
|---|---|
| Ceramics | **97.6 kg** |
| Textiles | **427.7 kg** |
| Granite | **3.5 kg** |
| | **...** |

# Conversion

## Total operational $CO_2$ eq per day

**199 kg**

Which equals to a 3 hours flight from Paris to Lisbon (1 000 km).

## Total embodied $CO_2$ eq over lifetime

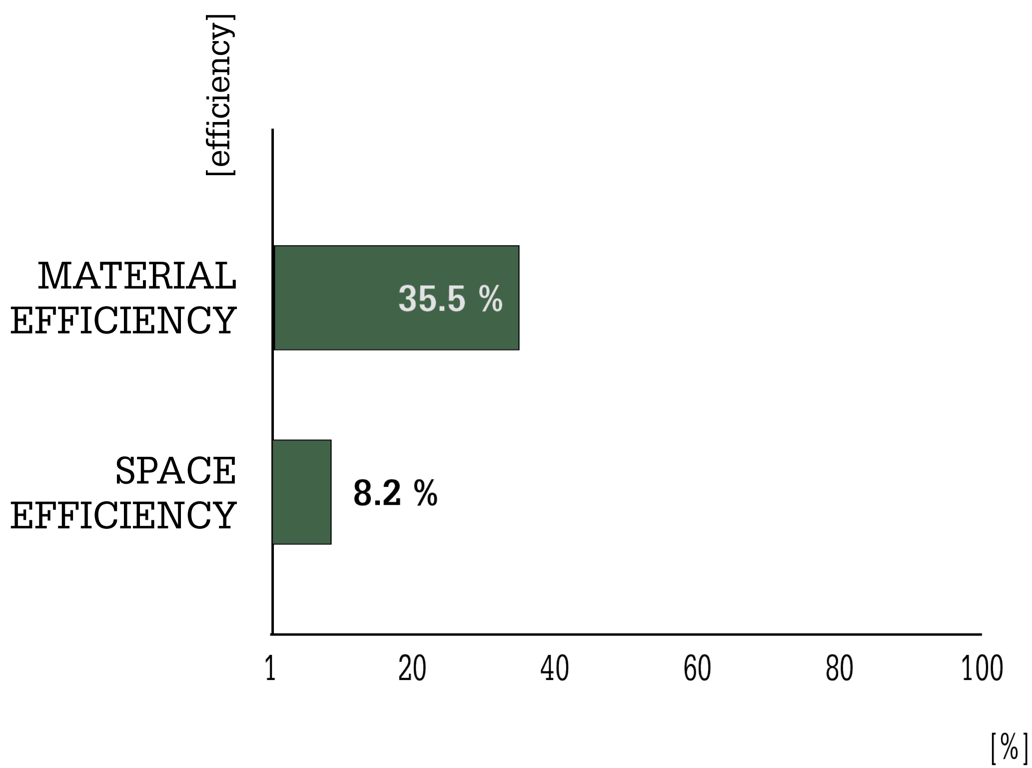
**148 887.7 kg**

Which equals to a 18.5 hours flight from Singapore to New York (16 304 km).

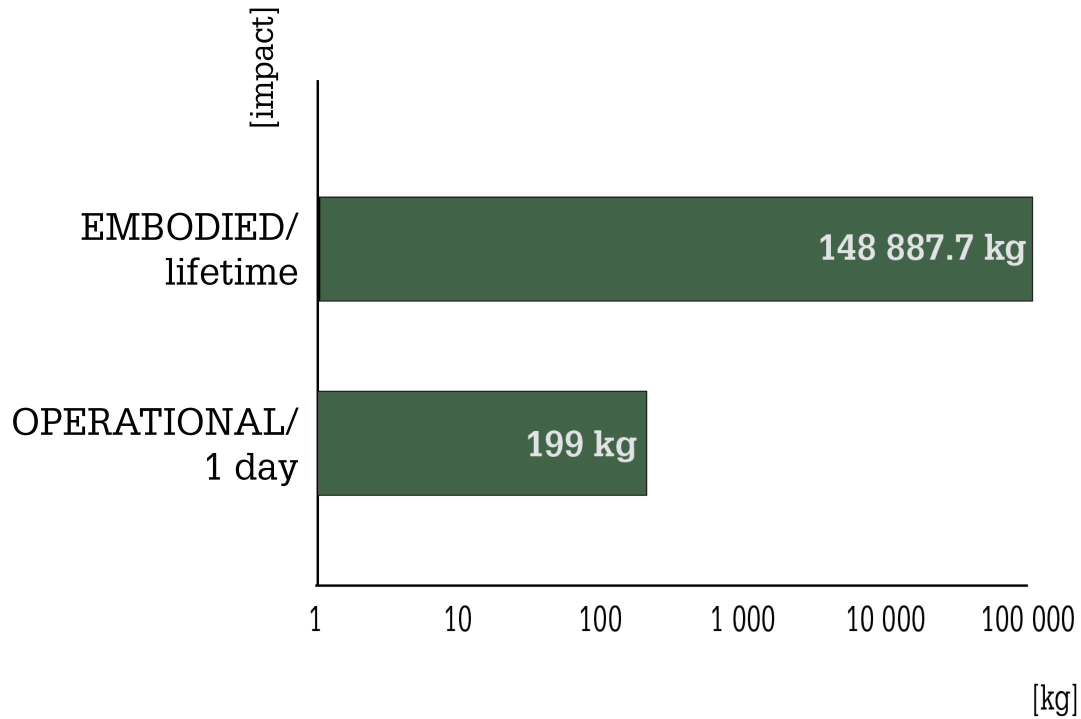
# COMMON COIN

# Common coin of the House of today

## Household EFFICIENCY




## Household IMPACT



**This chapter established four different common coins: the material efficiency, the space efficiency, the operational CO2 impact for one day and the embodied CO2 impact for the lifetime.**

# CAN WE DESIGN A HOUSEHOLD THAT PERFORMS BETTER?

# HOUSEHOLD WITH A BETTER MATERIAL EFFICIENCY?

# … WITH A BETTER SPACE EFFICIENCY?

# … WITH A SMALLER IMPACT?

# 5
# MATERIALS

# WHAT ARE THE MATERIALS NEEDS?

## List of activities

# The day is made of ...

Sleeping

Waking up

Taking a shower or a bath

Changing clothes

Cooking

Eating

Cleaning

Doing sport

Leaving

Coming back

Watching TV

Doing homework

Receiving guest

...

## Needs and wishes

# What is required ?

**Oxygen:** produces oxygen

**Furniture:** facilitates comfortable use for human activities

**Structure:** load-bearing

**Nutrition:** produces and/or stores food

**Water:** collects, filters and/or stores water

**Transparency:** lets light through

**Ventilation:** is permeable to gases

**Electricity:** lets electrical current to flow through

**Light:** illuminates surfaces

**Smell insulation:** is impermeable to odour

**Sound insulation:** prevents the sound waves from permeating

**Thermal insulation:** limits heat transfer

**Waste:** processes waste products ($CO_2$, waste-water etc.)

**Fire-resistant:** withstands fire for a limited amount of time

**Corrosion-resistant:** withstands corrosive damage from chemicals

**Elastic:** stretches and returns to its original form

**Recyclability:** can be repurposed

**Biodegradability:** decomposes naturally over time

**Adaptability:** changes form and stays that way multiple times

**Fauna hosting:** supports the survival and reproduction of a species

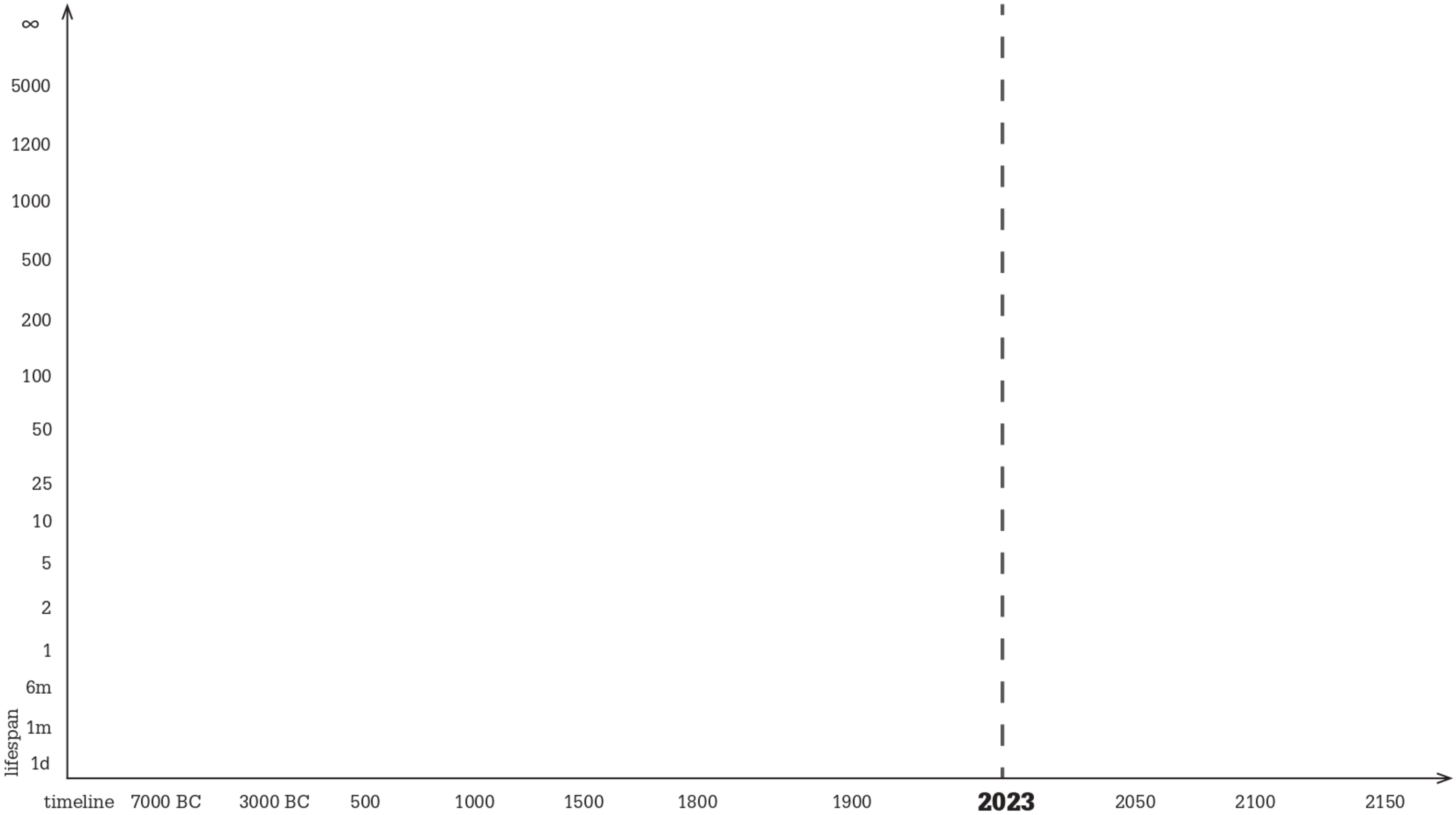
**Flora-hosting:** acts as a substrate for plants

**Self-repairing:** regenerates damages

**Durability:** withstands time and does not show wear and tear

# WHICH MATERIALS CAN FULFILL THESE NEEDS?

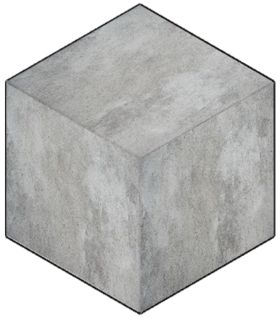
# The timeline of materials



# 5.2 MATERIALS OF TODAY

The materials used in construction today, from the most common to the least common.

# Reinforced Concrete



**Lifespan :** 30-150 years
**Footprint :** 635kg COs/m3

**For each material, the lifespan in years and carbon footprint CO/m3 are given.**

## Properties:

**All materials have properties that reflect the needs and wishes deriving from the activities.**

- [ ] Oxygen
- [x] Furniture
- [x] Structure
- [ ] Heat
- [ ] Nutrition
- [ ] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [x] Sound insulation

- [ ] Thermal insulation
- [ ] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [ ] Biodegredability
- [ ] Adaptability
- [ ] Fauna hosting
- [ ] Flora hosting
- [ ] Self-healing
- [x] Durability

## Limitations:

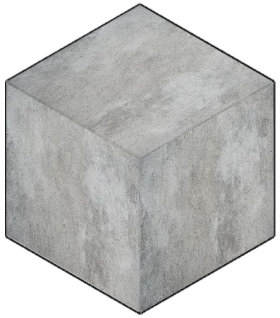
**All materials have their own innate limitations.**

- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

**These properties and limitations are expressed using these cubes, if they are filled it means that the material corresponds to them.**

# Reinforced Concrete

Reinforced concrete is a widely used construction material composed of concrete and embedded steel reinforcement.



**Lifespan :** 30-150 years
**Footprint :** 635kg $CO_2/m^3$

## Properties:

- [ ] Oxygen
- [x] Furniture
- [x] Structure
- [ ] Heat
- [ ] Nutrition
- [ ] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [x] Sound insulation
- [ ] Thermal insulation
- [ ] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [ ] Biodegredability
- [ ] Adaptability
- [ ] Fauna hosting
- [ ] Flora hosting
- [ ] Self-healing
- [x] Durability

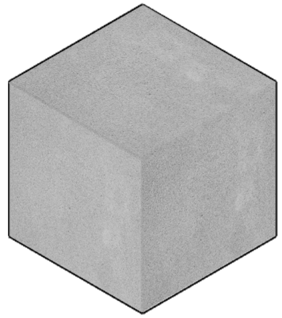
## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

[Source: Vipkatalogus.hu]

# Precast Concrete

Precast concrete is a construction material that is manufactured in a controlled environment and then transported to the construction site for installation. Higher cost than on-site construction.



**Lifespan :** 30-100 years
**Footprint :** 173.8 kg $CO_2/m^3$

## Properties:

- [ ] Oxygen
- [x] Furniture
- [x] Structure
- [ ] Heat
- [ ] Nutrition
- [ ] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [x] Sound insulation
- [ ] Thermal insulation
- [ ] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [ ] Biodegredability
- [ ] Adaptability
- [ ] Fauna hosting
- [ ] Flora hosting
- [ ] Self-healing
- [x] Durability

## Limitations:

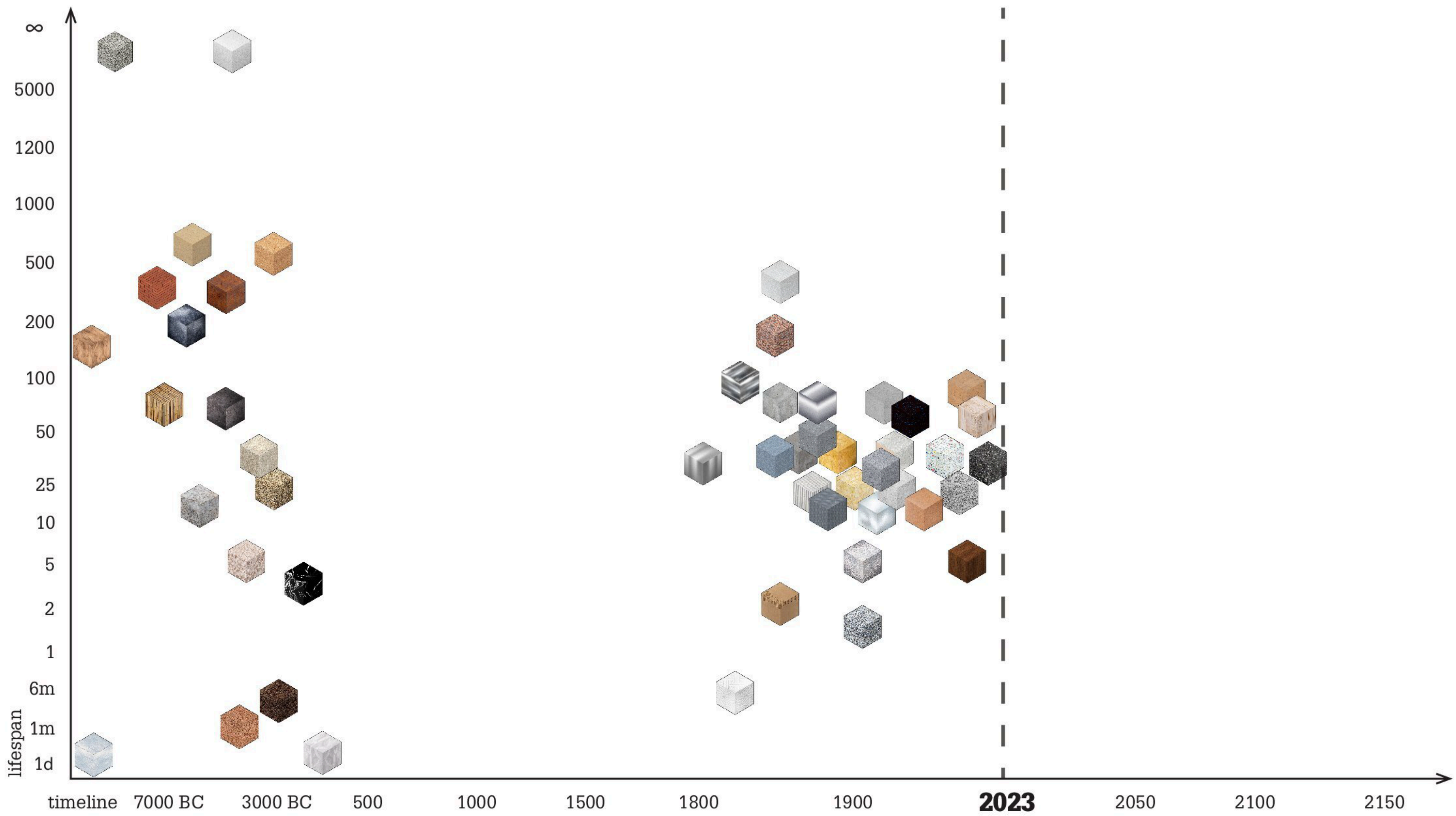
- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

[Source: Theconstructor.org]

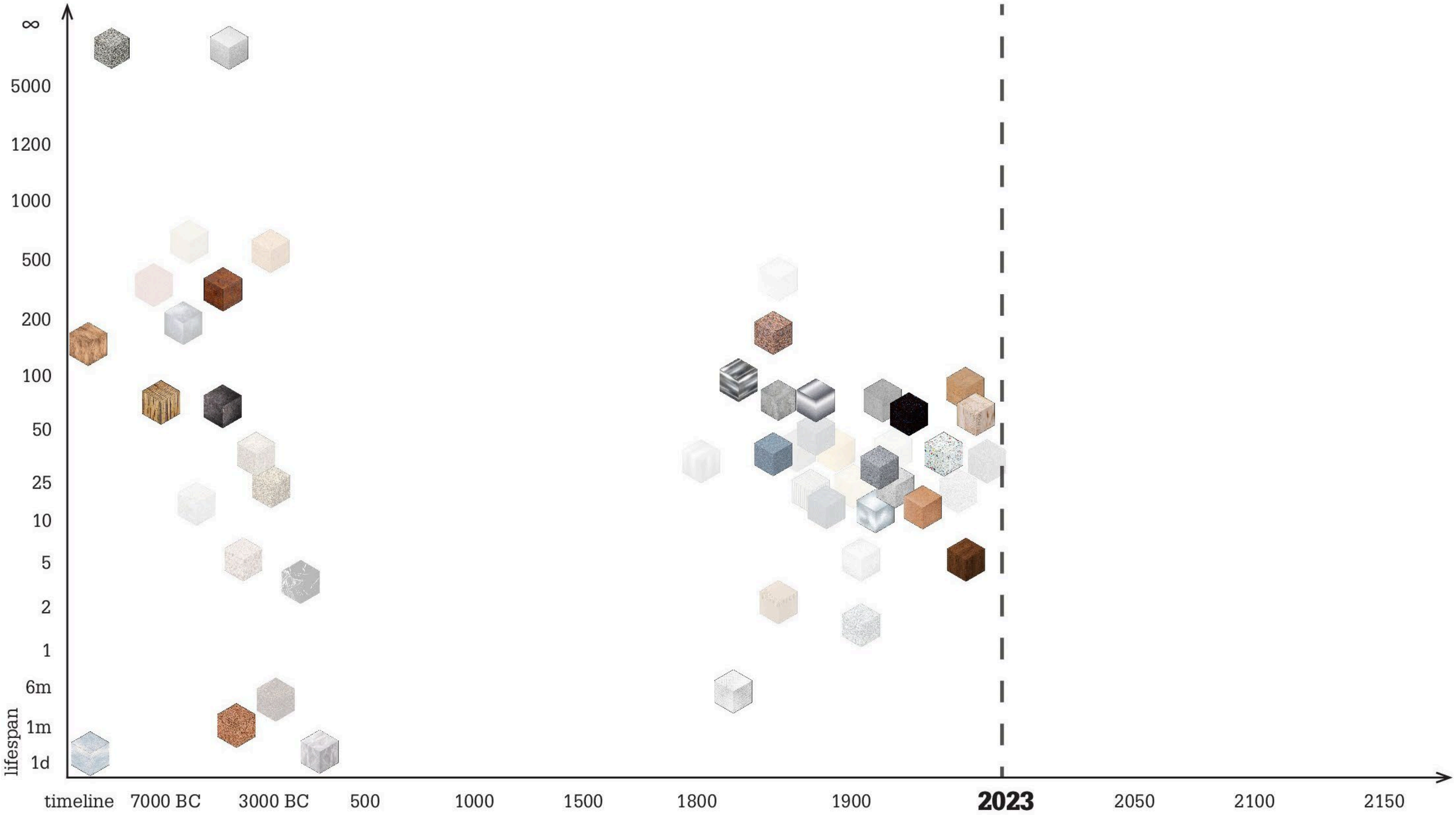
# Library of materials


# Library of materials

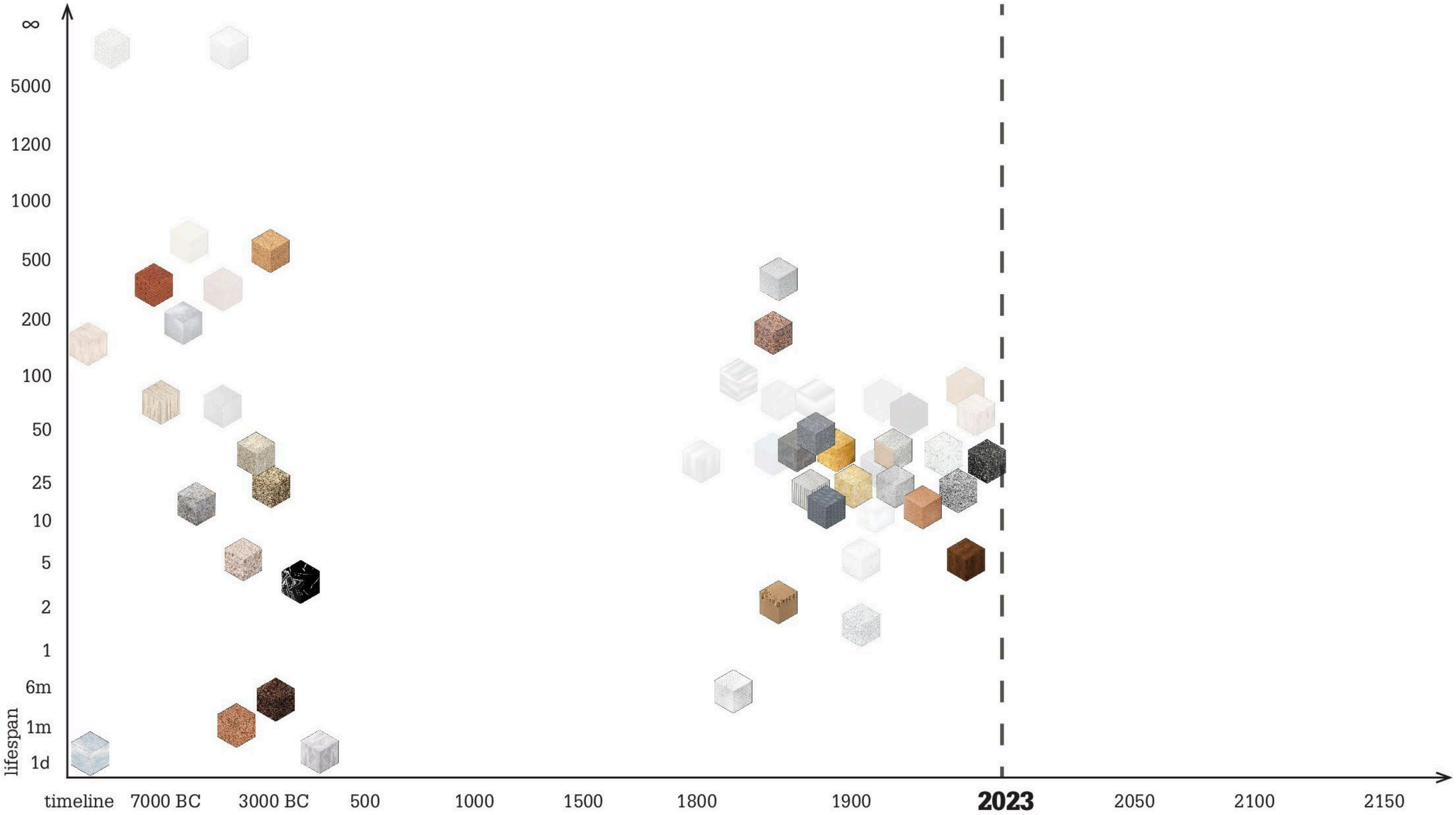
# The timeline of materials of today



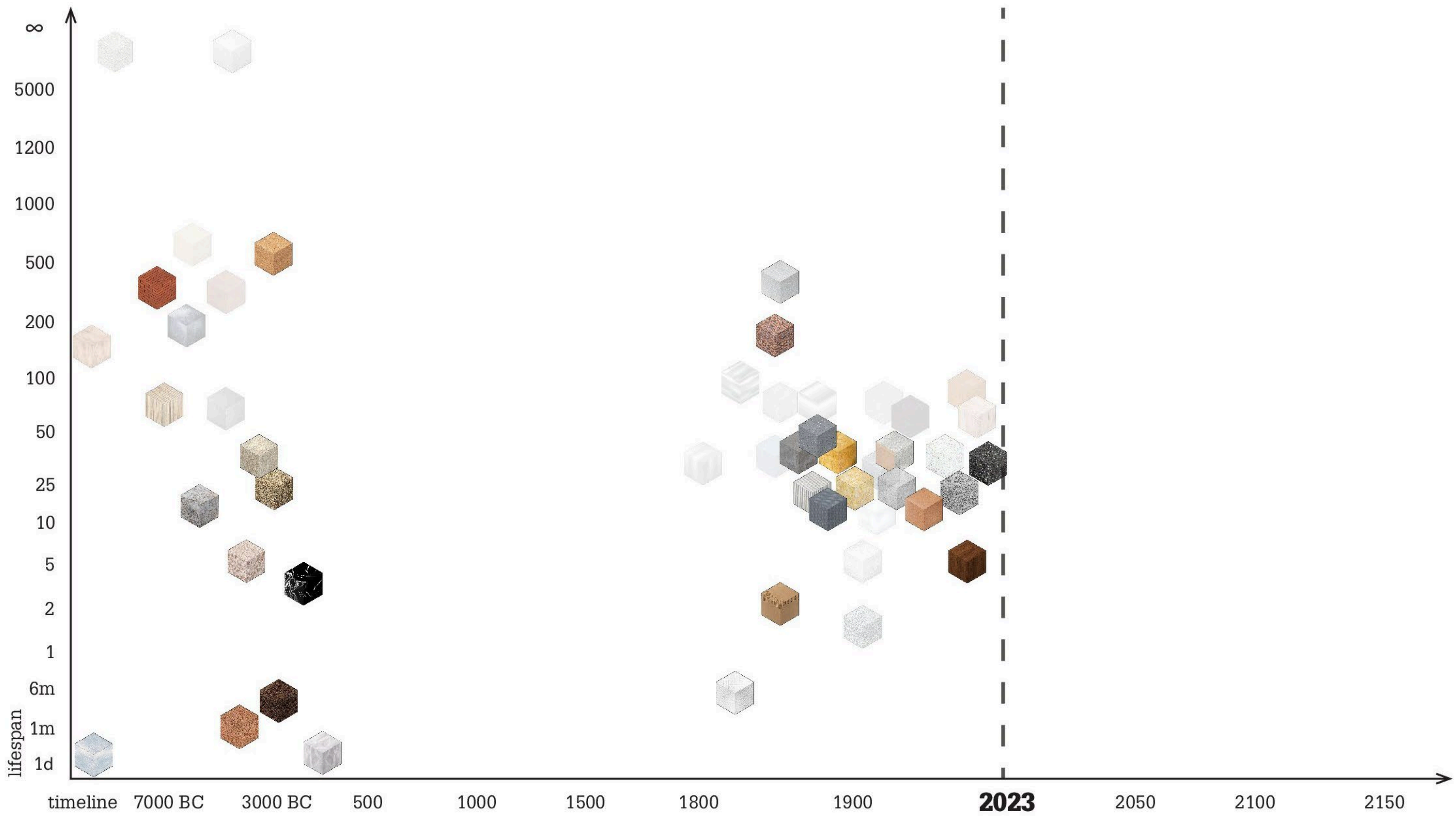
# The timeline of structural materials of today



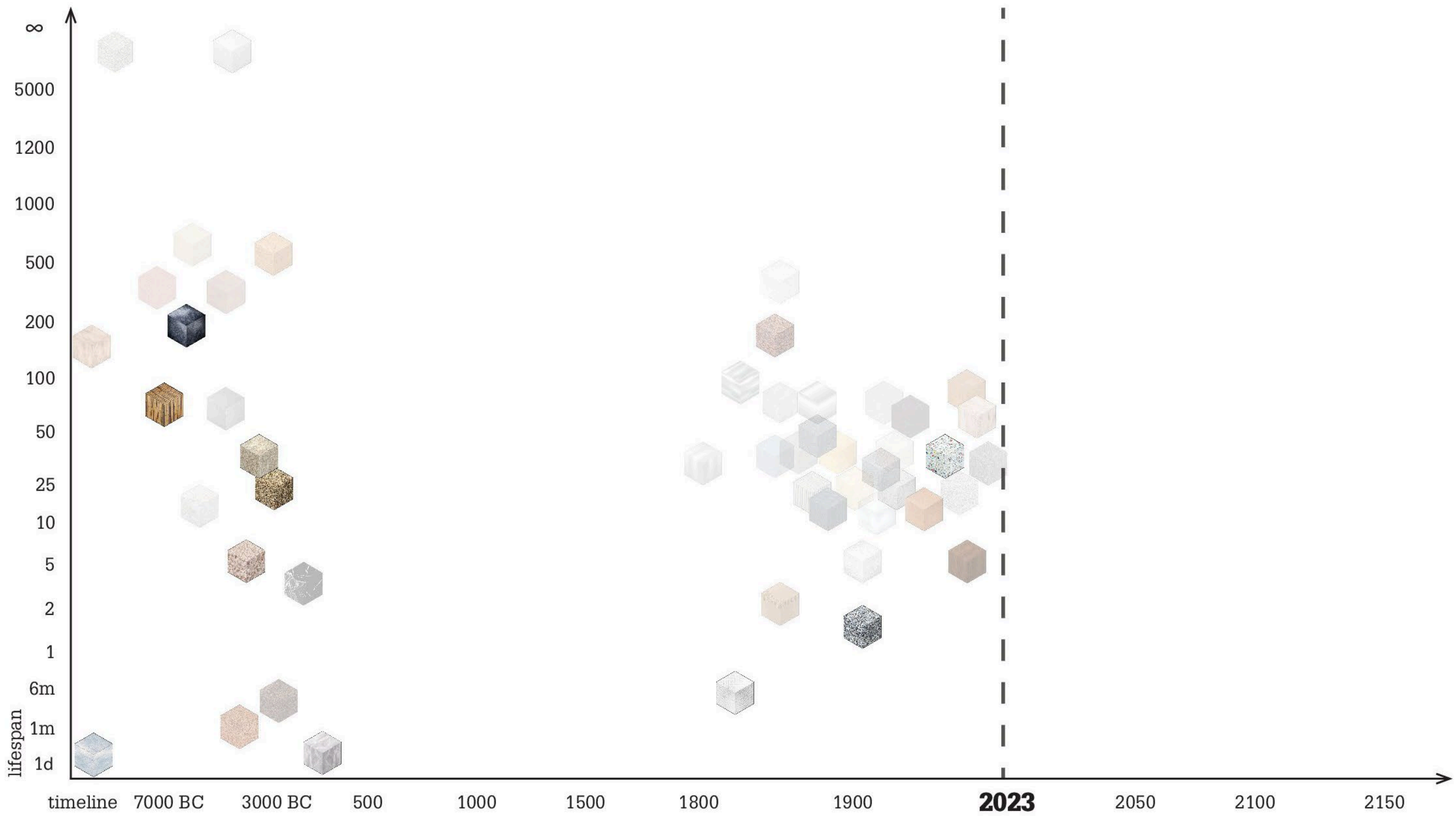
# The timeline of thermally insulating materials of today



# The timeline of recyclable materials of today



# The timeline of adaptable materials of today



# HOWEVER THESE MATERIALS ARE NOT YET EFFICIENT ENOUGH, LET'S INNOVATE!

# 5.3
# MATERIALS IN RESEARCH

**Buildings materials that are still being researched, that are not yet widely developed and used.**

# FOR EXAMPLE, WHAT ABOUT MYCELIUM?

# Fungal Mycelium

Mycelium is the vegetative, underground part of fungi.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- Oxygen
- Furniture
- Structure
- Heat
- Nutrition
- Water
- Transparency
- Ventilation
- Electricity
- Light
- Smell insulation
- Sound insulation
- Thermal insulation
- Waste
- Fire-resistant
- Corrosion-resistant
- Elastic
- Recyclability
- Biodegredability
- Adaptability
- Fauna hosting
- Flora hosting
- Self-healing
- Durability

## Limitations:

- Heat sensitive
- Cold sensitive
- Humidity
- Light sensitive
- Water dependent
- Water soluble
- Fragile
- Toxic

# Fungal Mycelium

As it grows, the mycelium will consume nutrients from organic substrates to form a dense network of interconnected fibers, binding together substrate particles. These bonds make this material adaptable, enabling different materials to communicate with each other. This symbiotic relationship is what makes this material flora hosting. As a mycorrhizal network, the mycelium and plants transfer resources to each other, making this material capable of helping nutrient production and storage, as well as water collection and circulation.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- [ ] Oxygen
- [ ] Furniture
- [ ] Structure
- [ ] Heat
- [x] Nutrition
- [x] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [ ] Sound insulation

- [ ] Thermal insulation
- [ ] Waste
- [ ] Fire-resistant
- [ ] Corrosion-resistant
- [ ] Elastic
- [ ] Recyclability
- [ ] Biodegredability
- [x] Adaptability
- [ ] Fauna hosting
- [x] Flora hosting
- [ ] Self-healing
- [ ] Durability

## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [x] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [x] Toxic

# Fungal Mycelium

Mycelium-based composites are naturally biodegradable and recyclable materials.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- [ ] Oxygen
- [ ] Furniture
- [ ] Structure
- [ ] Heat
- [x] Nutrition
- [x] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [ ] Sound insulation

- [ ] Thermal insulation
- [ ] Waste
- [ ] Fire-resistant
- [ ] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [x] Biodegredability
- [x] Adaptability
- [ ] Fauna hosting
- [x] Flora hosting
- [ ] Self-healing
- [ ] Durability

## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [x] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [x] Toxic

# Fungal Mycelium

Mycelium is already used in design as furniture and in construction as a thermal and sound insulation. This is made possible by a process that begins by sealing the mycelium culture with sawdust in a sterile bag. After 3 weeks, the mycelium can be released, grated and mixed with a substrate containing cellulose, then placed in a mold where it must incubate for a further 7 days. Once the required properties have been achieved, the growth process is stopped by a high-temperature treatment.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- [ ] Oxygen
- [x] Furniture
- [ ] Structure
- [ ] Heat
- [x] Nutrition
- [x] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [x] Sound insulation

- [x] Thermal insulation
- [ ] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [x] Biodegredability
- [x] Adaptability
- [ ] Fauna hosting
- [x] Flora hosting
- [ ] Self-healing
- [ ] Durability

## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [x] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [x] Toxic

# Fungal Mycelium

One of the main limitations of this material is that if we don't heat and dry it before using it, it will continue to grow and develop fungi on its surface that will release spores. Combined with a material capable of covering the mycelium to absorb and evacuate the spores, then we could use the living mycelium in the construction. This would make this material durable and self-repairing.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- ☐ Oxygen
- ■ Furniture
- ☐ Structure
- ☐ Heat
- ■ Nutrition
- ■ Water
- ☐ Transparency
- ☐ Ventilation
- ☐ Electricity
- ☐ Light
- ☐ Smell insulation
- ■ Sound insulation

- ■ Thermal insulation
- ☐ Waste
- ■ Fire-resistant
- ■ Corrosion-resistant
- ☐ Elastic
- ■ Recyclability
- ■ Biodegredability
- ■ Adaptability
- ☐ Fauna hosting
- ■ Flora hosting
- ■ Self-healing
- ■ Durability

## Limitations:

- ☐ Heat sensitive
- ☐ Cold sensitive
- ■ Humidity
- ☐ Light sensitive
- ☐ Water dependent
- ☐ Water soluble
- ☐ Fragile
- ☐ Toxic

# Fungal Mycelium

Mycelium can be used as a self-supporting structure. By finding the right substrate and a way of desensitizing the mycelium to water and humidity, with wax for example, it would be possible for this material to have stronger structural properties.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- [ ] Oxygen
- [x] Furniture
- [ ] Structure
- [ ] Heat
- [x] Nutrition
- [x] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [x] Sound insulation

- [x] Thermal insulation
- [x] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [x] Biodegredability
- [x] Adaptability
- [ ] Fauna hosting
- [x] Flora hosting
- [x] Self-healing
- [x] Durability

## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

# Fungal Mycelium

It's also possible to work with mycelium and improve it using 3D printing, in particular to save time. Printing can be carried out using a mycelium base to which substrates are added. On a small scale, 3D printing is carried out using a robotic arm, which works from the coordinates provided by the 3D model. The process is preceded by syringe tests: this involves combining different quantities of the materials used and monitoring the properties and changes of each mixture. The test pieces are then baked in a high-temperature oven and dry.

**Lifespan :** 10-200 years
**Footprint :** Absorbs $CO_2$

## Properties:

- [ ] Oxygen
- [x] Furniture
- [ ] Structure
- [ ] Heat
- [x] Nutrition
- [x] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [ ] Smell insulation
- [x] Sound insulation
- [x] Thermal insulation
- [x] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [x] Recyclability
- [x] Biodegredability
- [x] Adaptability
- [ ] Fauna hosting
- [x] Flora hosting
- [x] Self-healing
- [x] Durability

## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

[Source: Dezeen.com]

# LET'S LOOK AT THE OTHER MATERIALS STILL IN RESEARCH

# Self-healing Concrete

Self-healing concrete refers to the ability of concrete to autonomously repair cracks. Research on mineral additions, like blast-furnace slag and fly ash, focuses on promoting autogenous healing. Continuous hydration, especially with these additions, supports self-healing as significant portions remain unhydrated even in later stages. The pozzolanic reaction, specific to additions in composite cement (fly ash, blast-furnace slag, silica fume, calcined clay, etc.), enhances cement grain hydration, leading to long-term calcium silicate hydrate (CSH) development and some degree of autogenous self-healing.

**Lifespan :** -
**Footprint :** 20 kg $CO_2$/ $m^2$

## Properties:

- [ ] Oxygen
- [x] Furniture
- [x] Structure
- [ ] Heat
- [ ] Nutrition
- [x] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [x] Smell insulation
- [ ] Sound insulation
- [ ] Thermal insulation
- [ ] Waste
- [x] Fire-resistant
- [x] Corrosion-resistant
- [ ] Elastic
- [ ] Recyclability
- [ ] Biodegredability
- [ ] Adaptability
- [ ] Fauna hosting
- [ ] Flora hosting
- [x] Self-healing
- [x] Durability

## Limitations:

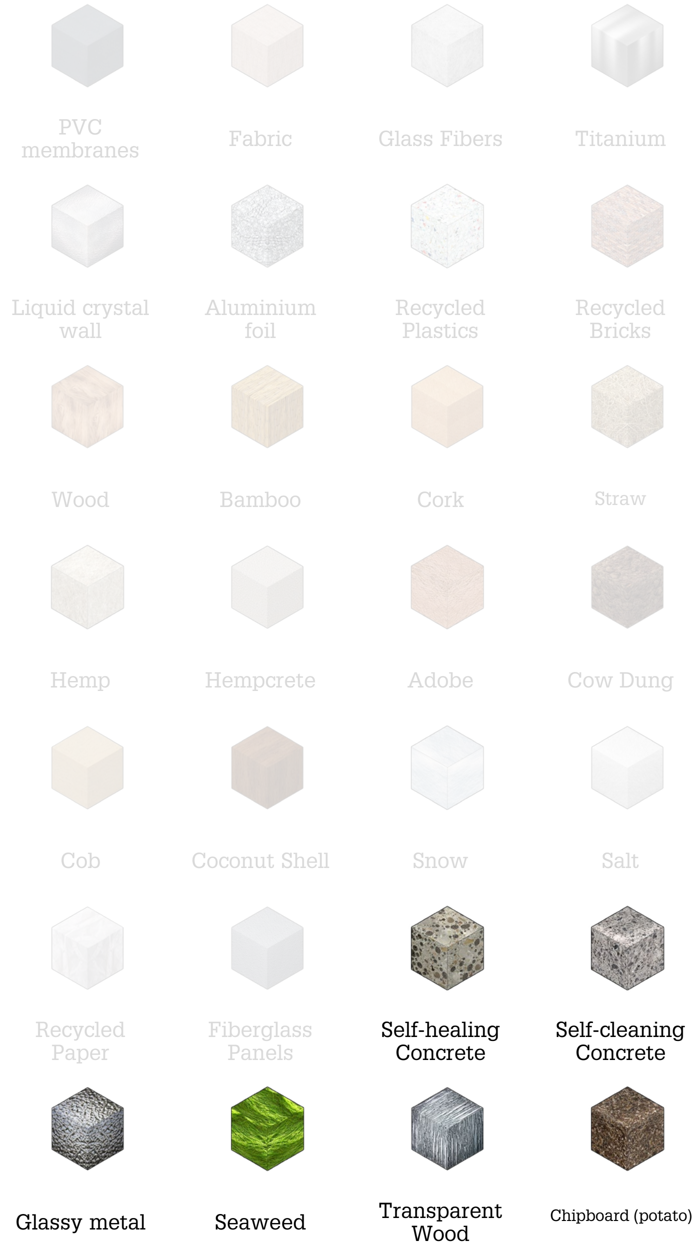
- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

[Source: Nationa Library of Medecine]

[Source: Checkatrade.com]

# Library of materials

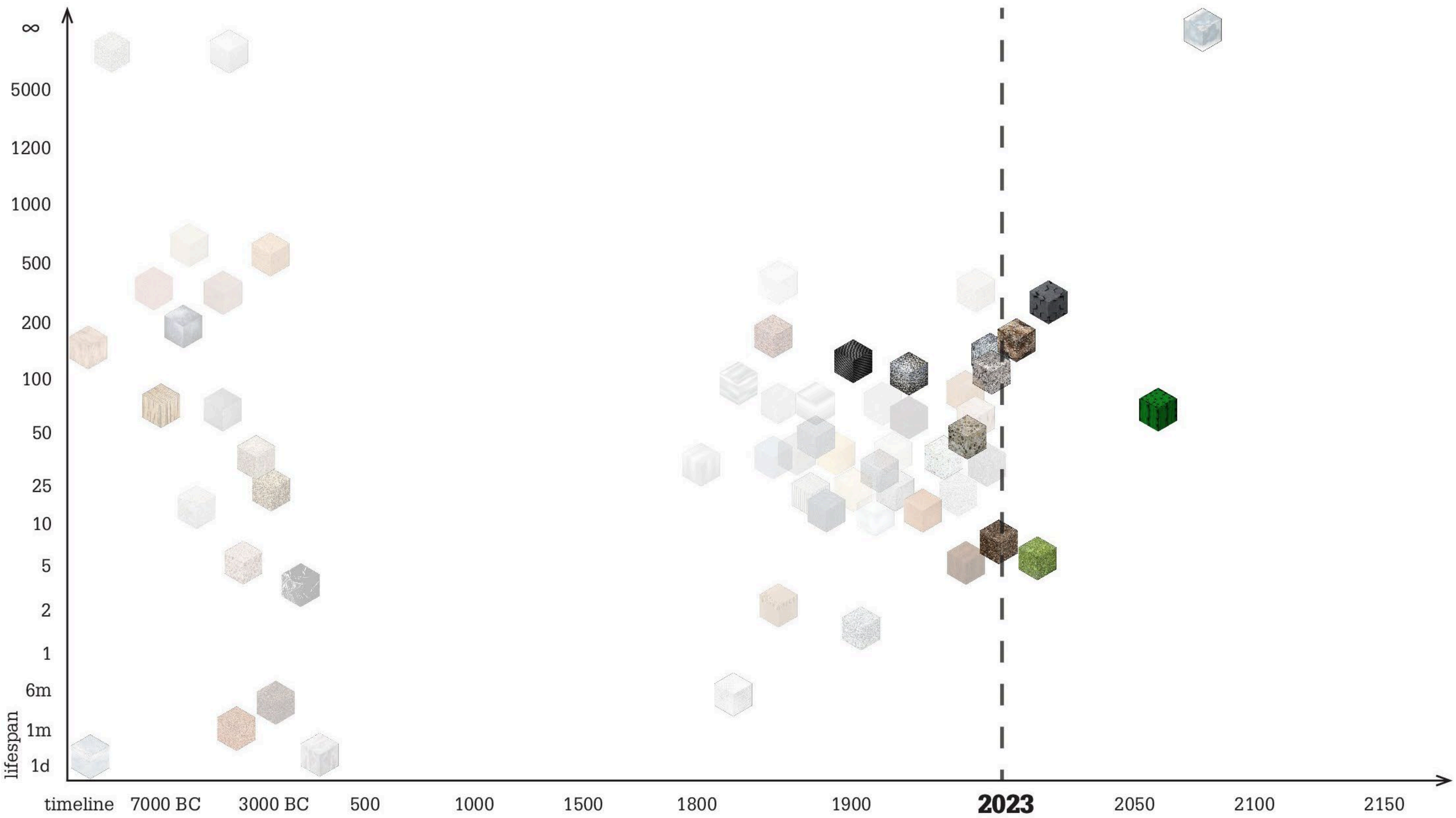


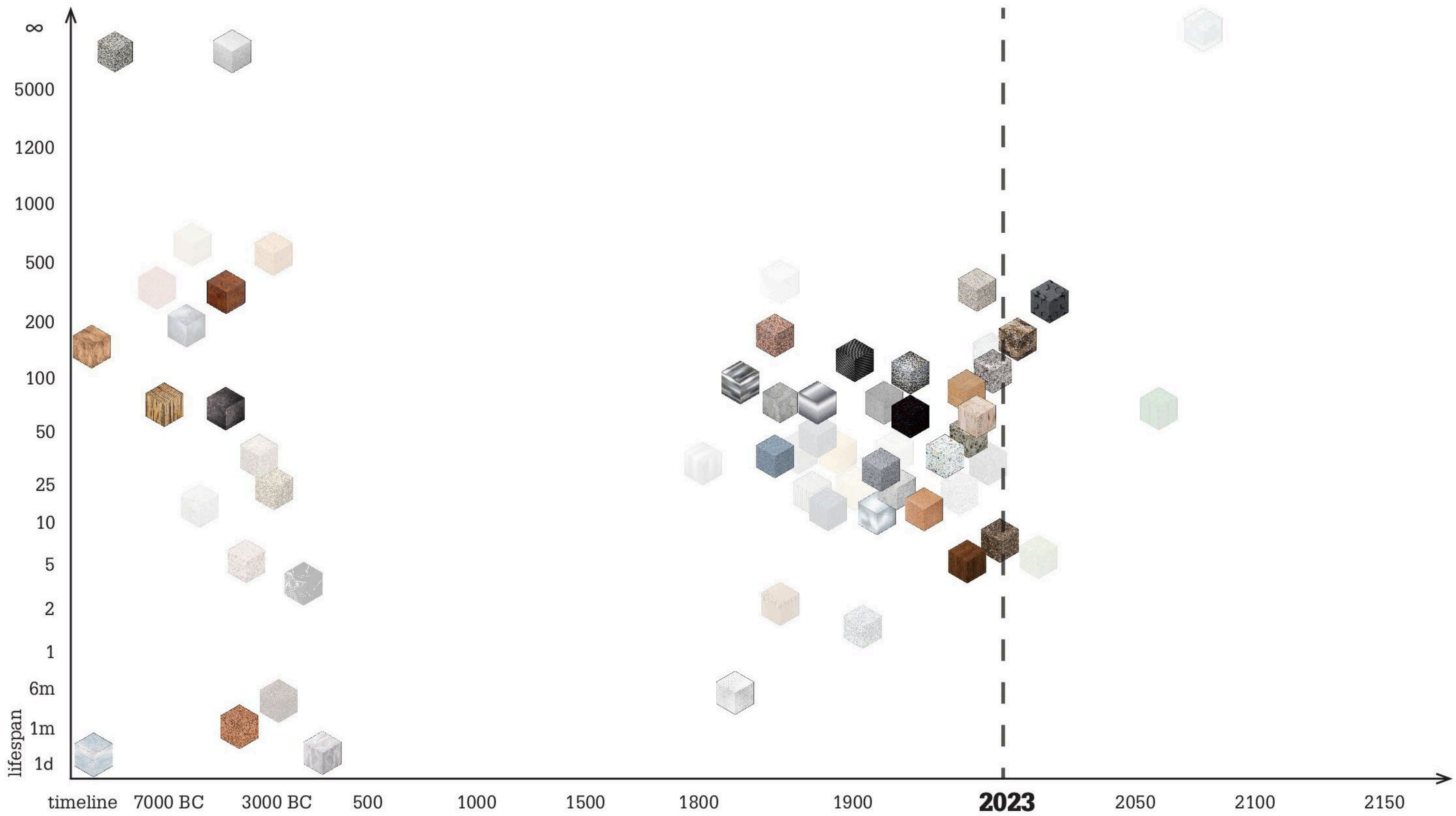
## 5.3 MATERIALS IN RESEARCH

# Library of materials

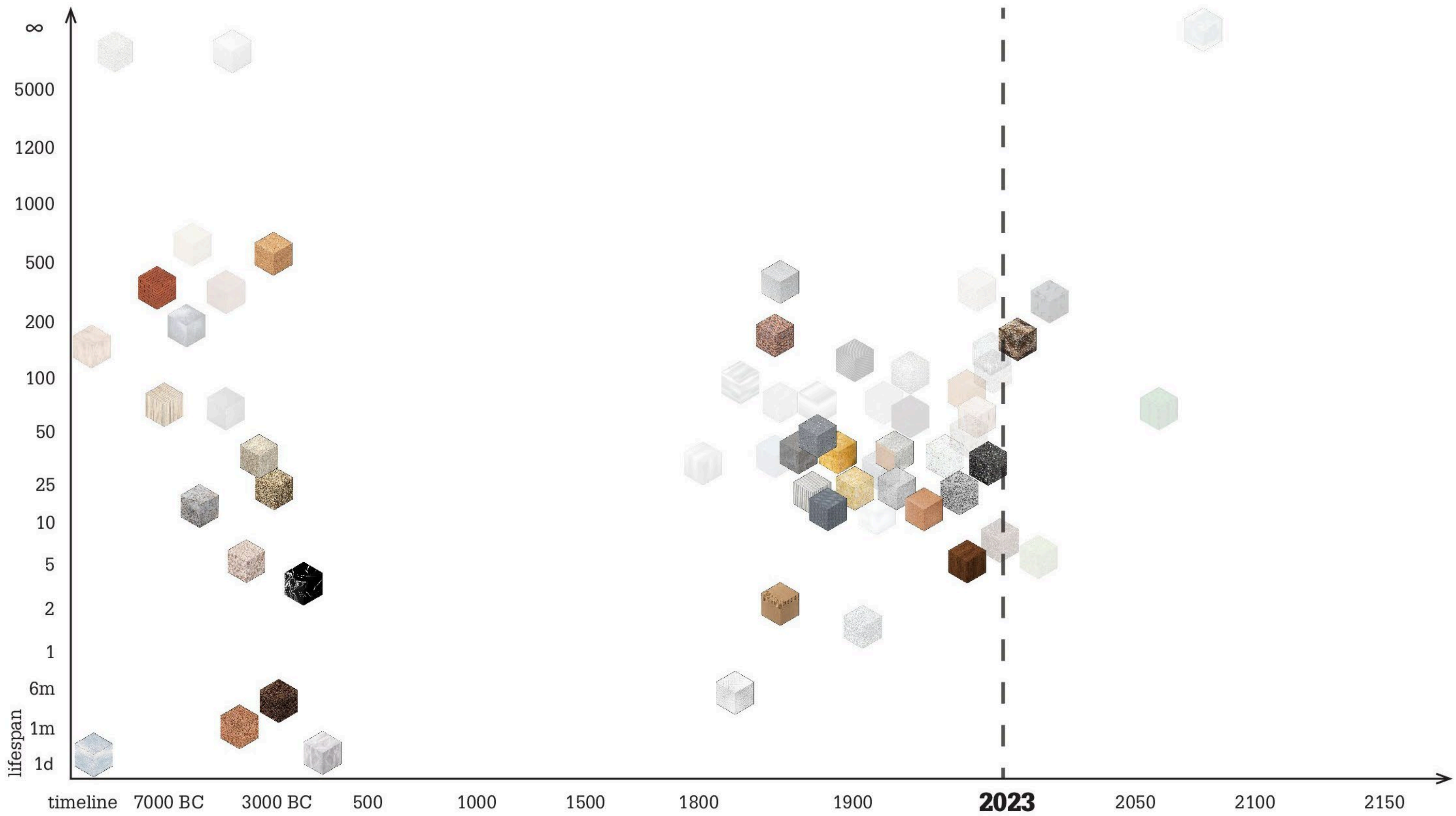
# The timeline of materials in research



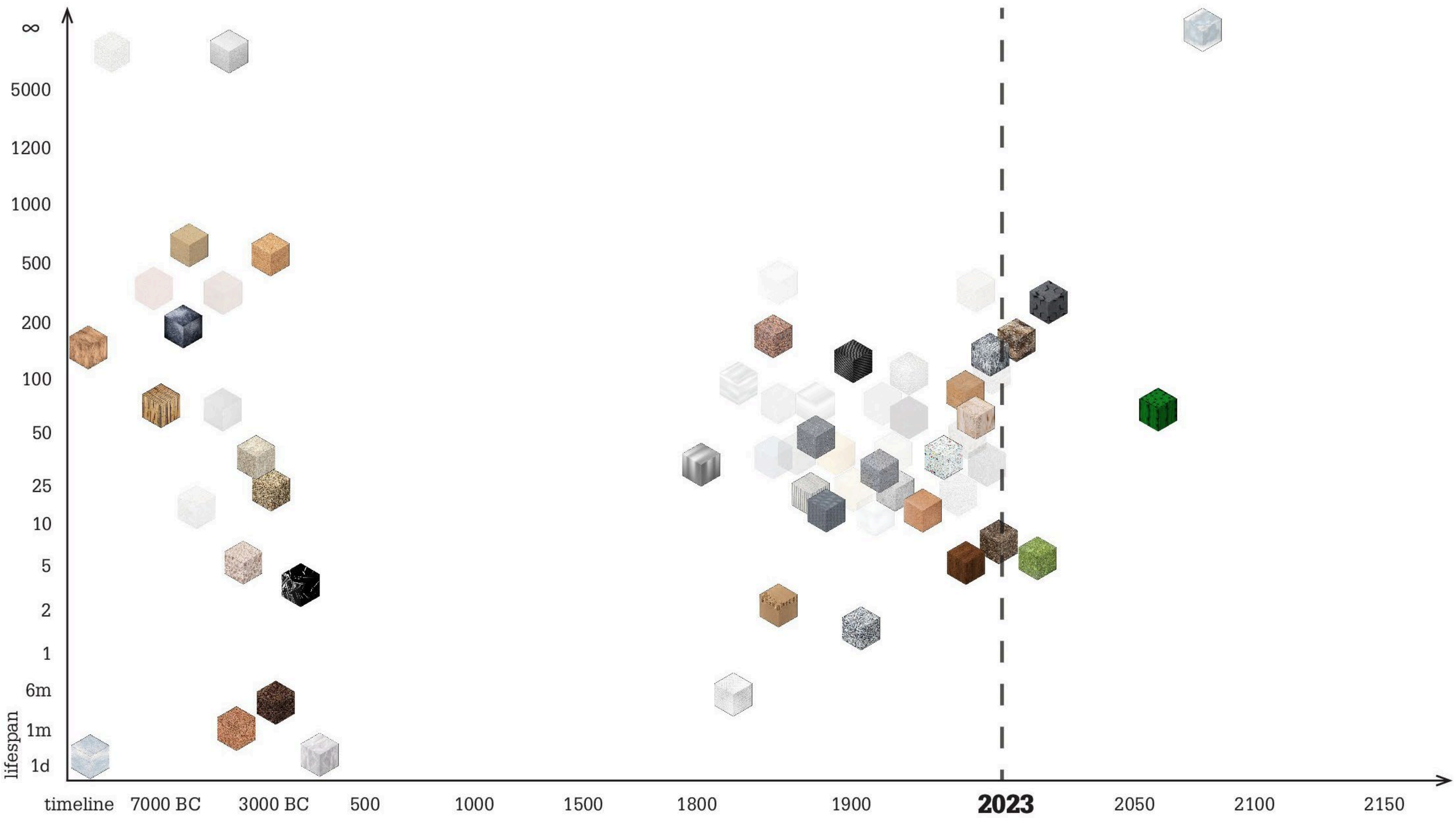
# The timeline of structural materials in research



# The timeline of thermally insulating materials in research



# The timeline of recyclable materials in research



# The timeline of adaptable materials in research

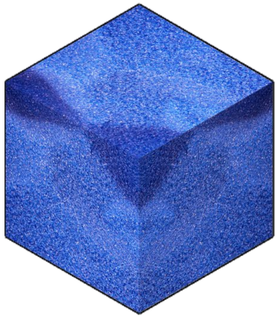
# WHAT OTHER MATERIALS LOOK PROMISING FOR THE FUTURE?

# 5.4
# MATERIALS OF THE FUTURE

**Materials that already exist in other fields, but whose potential application to architecture is only just beginning to be explored.**

# Elastomers

Elastomers are rubbery materials composed of long chainline of molecules. The are highly elastic, with various use in industrial products: soft robotics, astronautic equipment, vehicles, tissue engineering, self-healing. When stressed, the weak retained forces cause them to elongate greatly and become flexible and adhesive.



**Lifespan :** 15 years
**Footprint :** 1.5 t $CO_2$/t

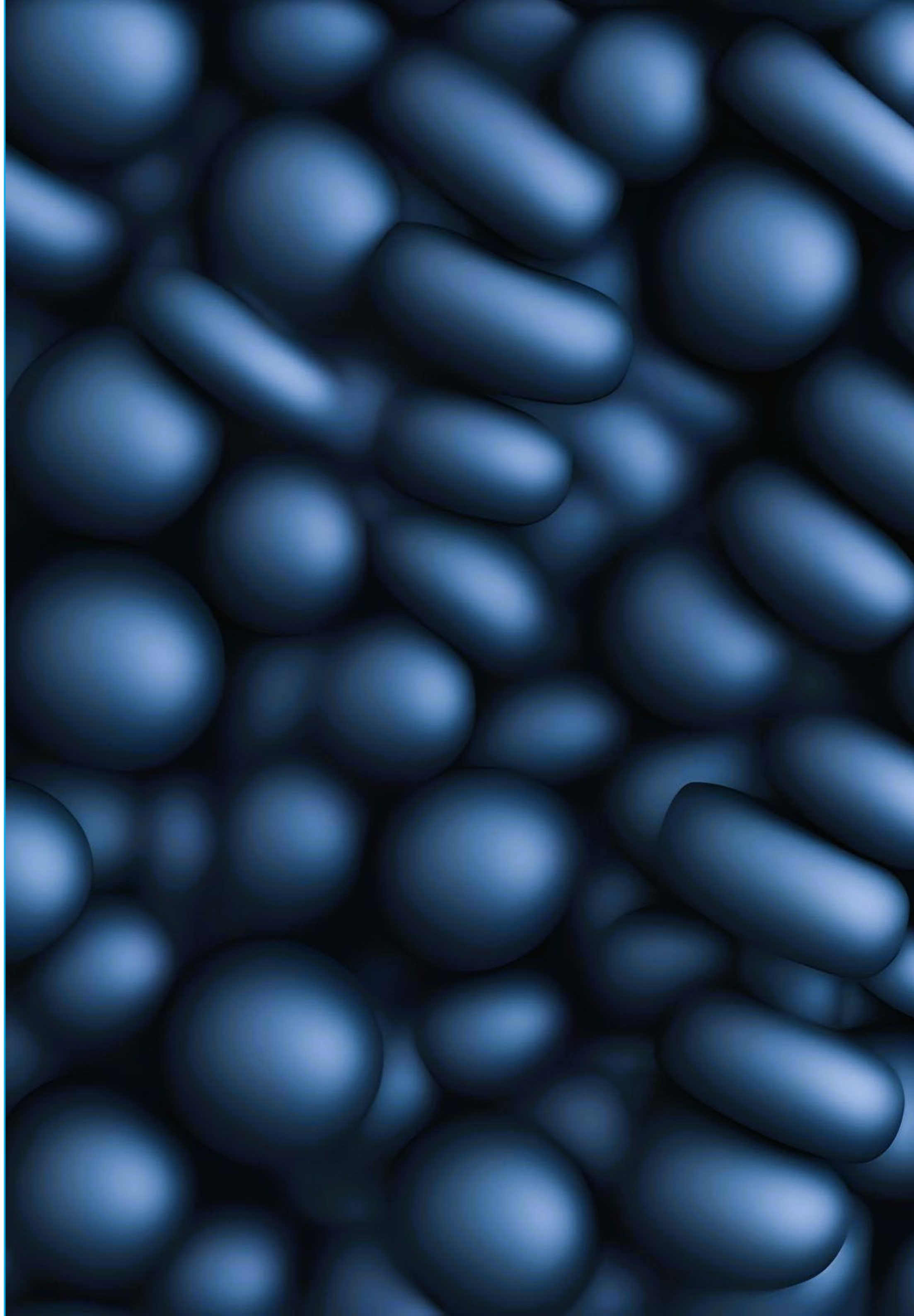
## Properties:

- [ ] Oxygen
- [ ] Furniture
- [ ] Structure
- [ ] Heat
- [ ] Nutrition
- [ ] Water
- [ ] Transparency
- [ ] Ventilation
- [ ] Electricity
- [ ] Light
- [x] Smell insulation
- [x] Sound insulation
- [ ] Thermal insulation
- [ ] Waste
- [ ] Fire-resistant
- [ ] Corrosion-resistant
- [x] Elastic
- [x] Recyclability
- [ ] Biodegredability
- [x] Adaptability
- [ ] Fauna hosting
- [ ] Flora hosting
- [ ] Self-healing
- [x] Durability

## Limitations:

- [ ] Heat sensitive
- [ ] Cold sensitive
- [ ] Humidity
- [ ] Light sensitive
- [ ] Water dependent
- [ ] Water soluble
- [ ] Fragile
- [ ] Toxic

[Source: Sciencedirect.com]



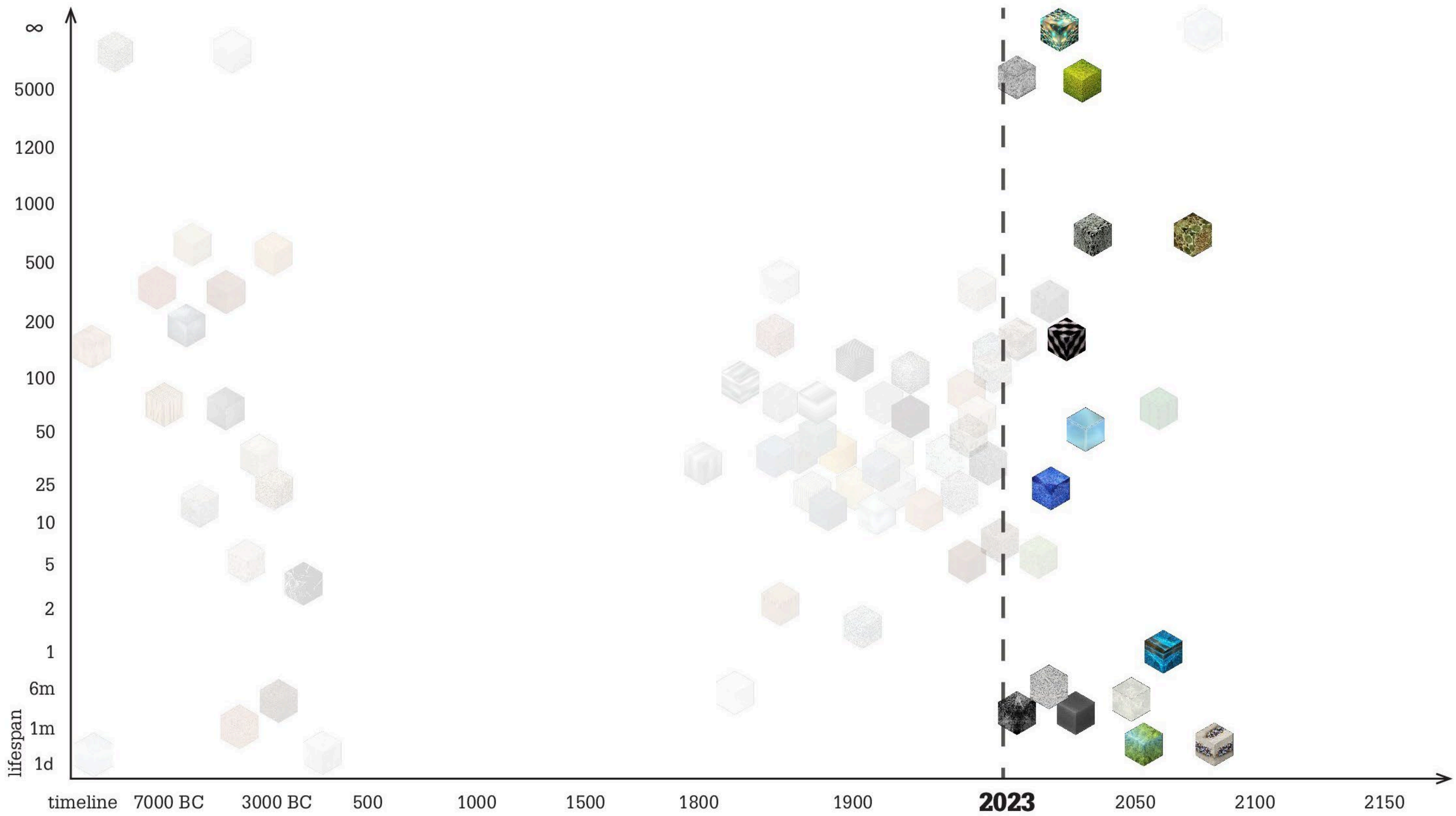
# Library of materials

| | | | |
|---|---|---|---|
| Reinforced concrete | Precast concrete | Translucent Concrete | Aerated Concrete |
| Terracotta Bricks | Asbestos-Cement | Steel | Stainless Steel |
| Iron | Stone | Polystyrene | Rock Wool |
| Glass/Mineral Wool | Sheep Wool | Phenolic Foam | Galvanised Steel Sheets |
| Copper | Lead | MDF | Plaster Panels |
| Corrugated Cardboard | Acrylic Glass (Plexiglass) | Rubber | Linoleum |
| CLT | GLT | Luminous Concrete | HIgh density gypsum |

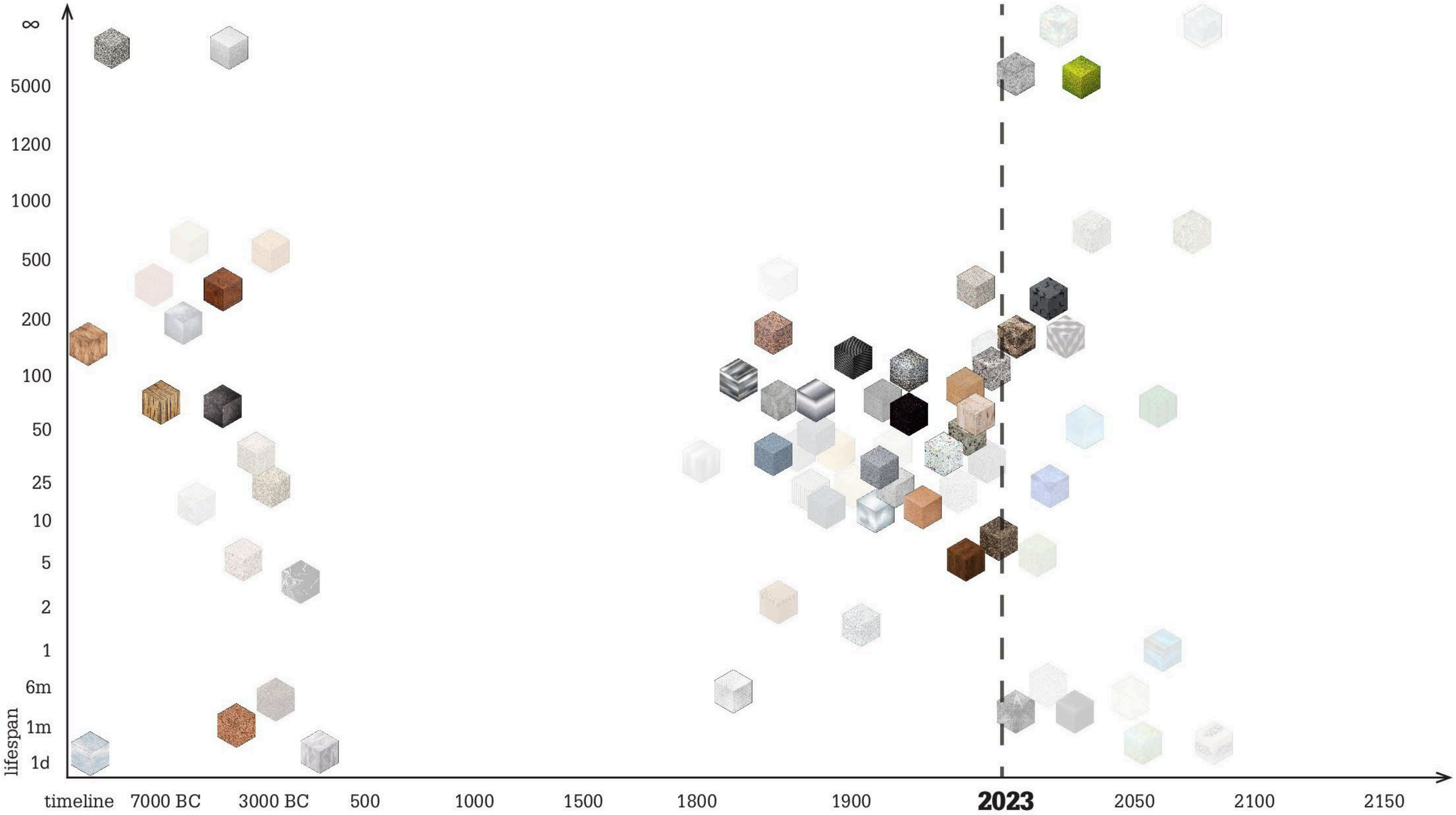
| | | | |
|---|---|---|---|
| PVC membranes | Fabric | Glass Fibers | Titanium |
| Liquid crystal wall | Aluminium foil | Recycled Plastics | Recycled Bricks |
| Wood | Bamboo | Cork | Straw |
| Hemp | Hempcrete | Adobe | Cow Dung |
| Cob | Coconut Shell | Snow | Salt |
| Recycled Paper | Fiberglass Panels | Self-healing Concrete | Self-cleaning Concrete |
| Glassy metal | Seaweed | Transparent Wood | Chipboard (potato) |

# Library of materials

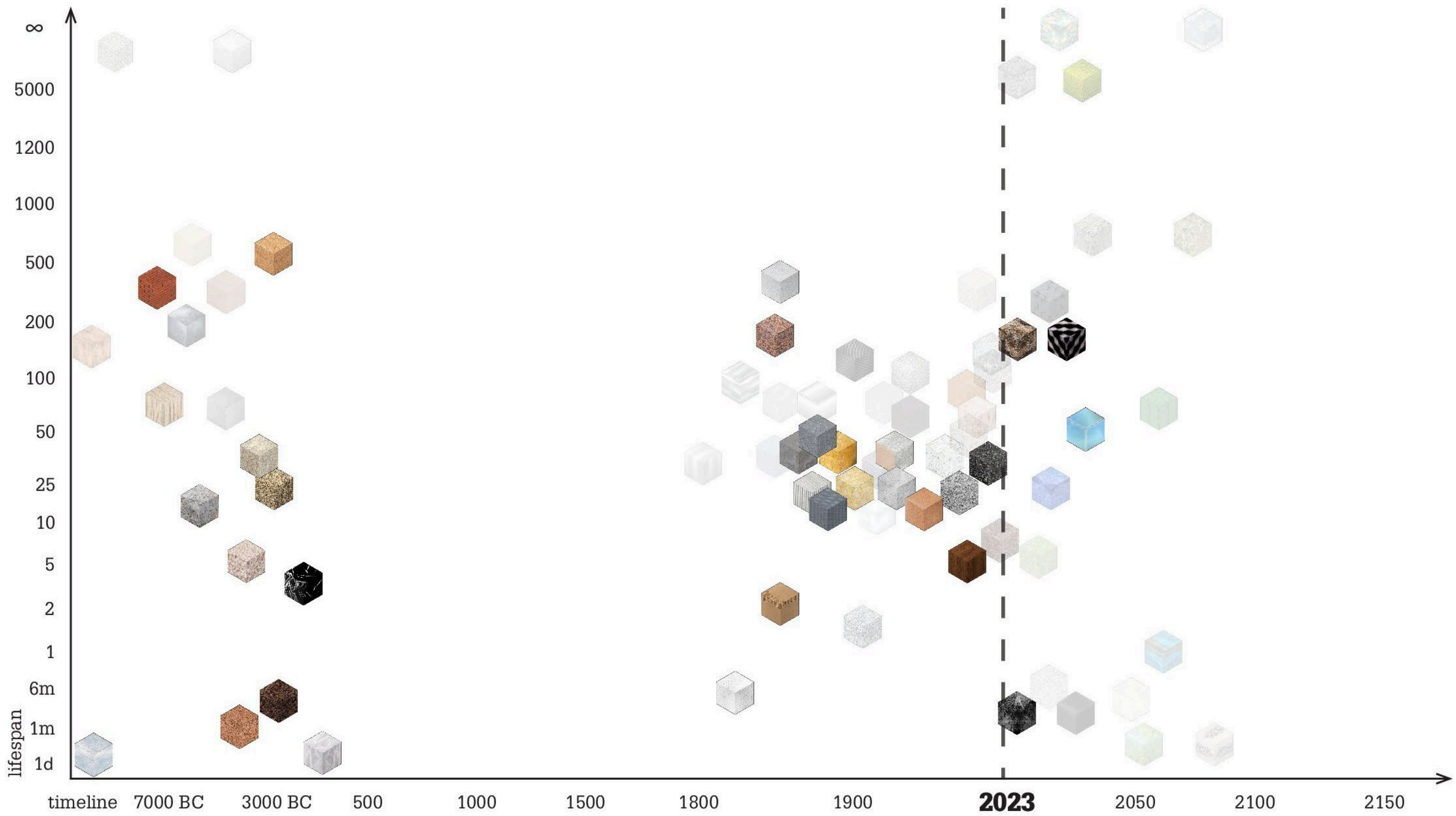
# The timeline of materials of the future



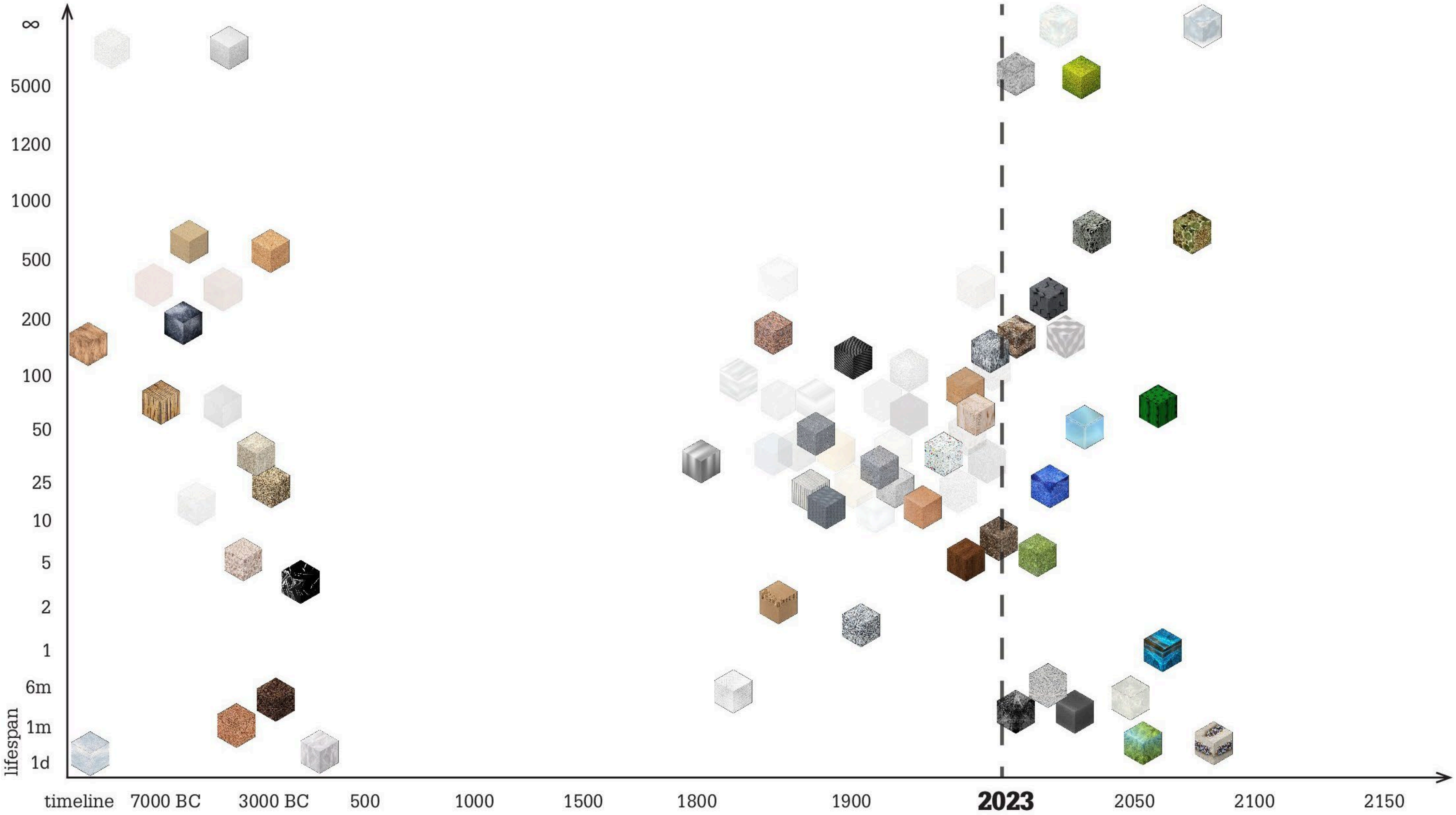
# The timeline of structural materials of the future



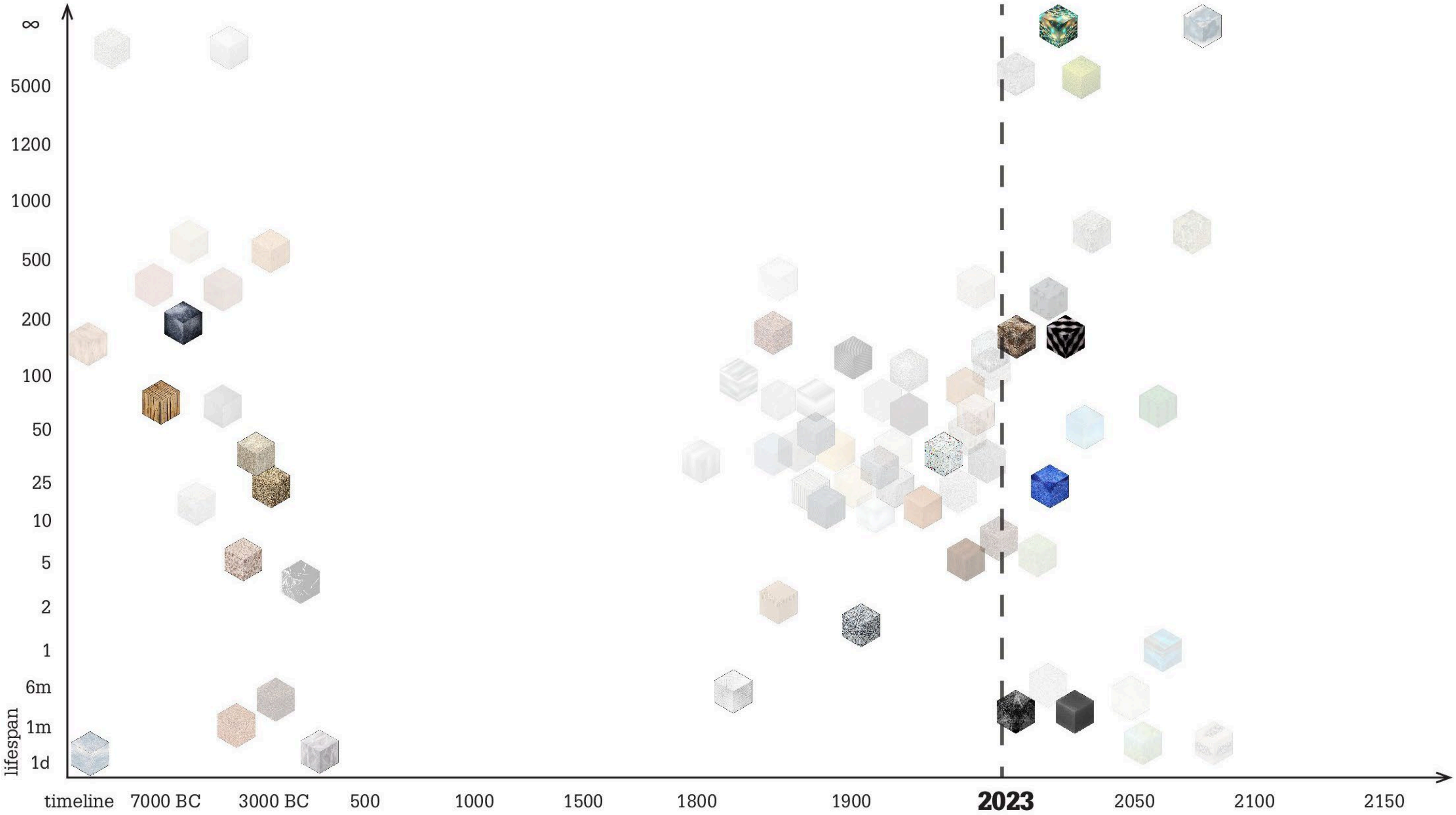
# The timeline of thermal insulating materials of the future



# The timeline of recyclable materials of the future



# The timeline of adaptable materials of the future



A great deal of research into materials has been carried out, enabling us to establish which materials can meet our desired properties for the Next House.

# HOW CAN THESE MATERIALS COLLABORATE TOWARDS THE NEXT HOUSE?

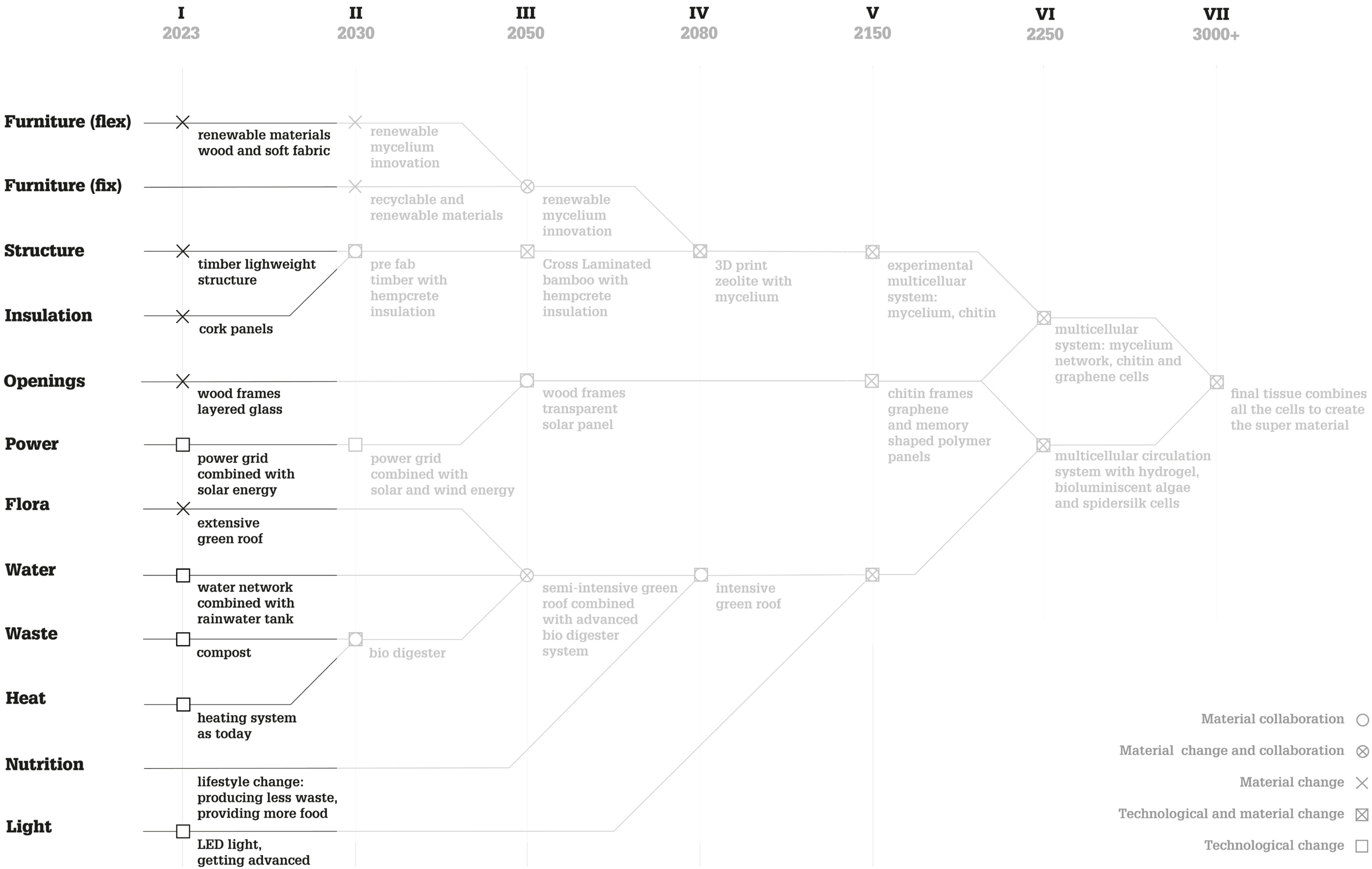
# 6
# NEXT HOUSE

# 6.1
# NEXT HOUSE IN THE CZECH REPUBLIC

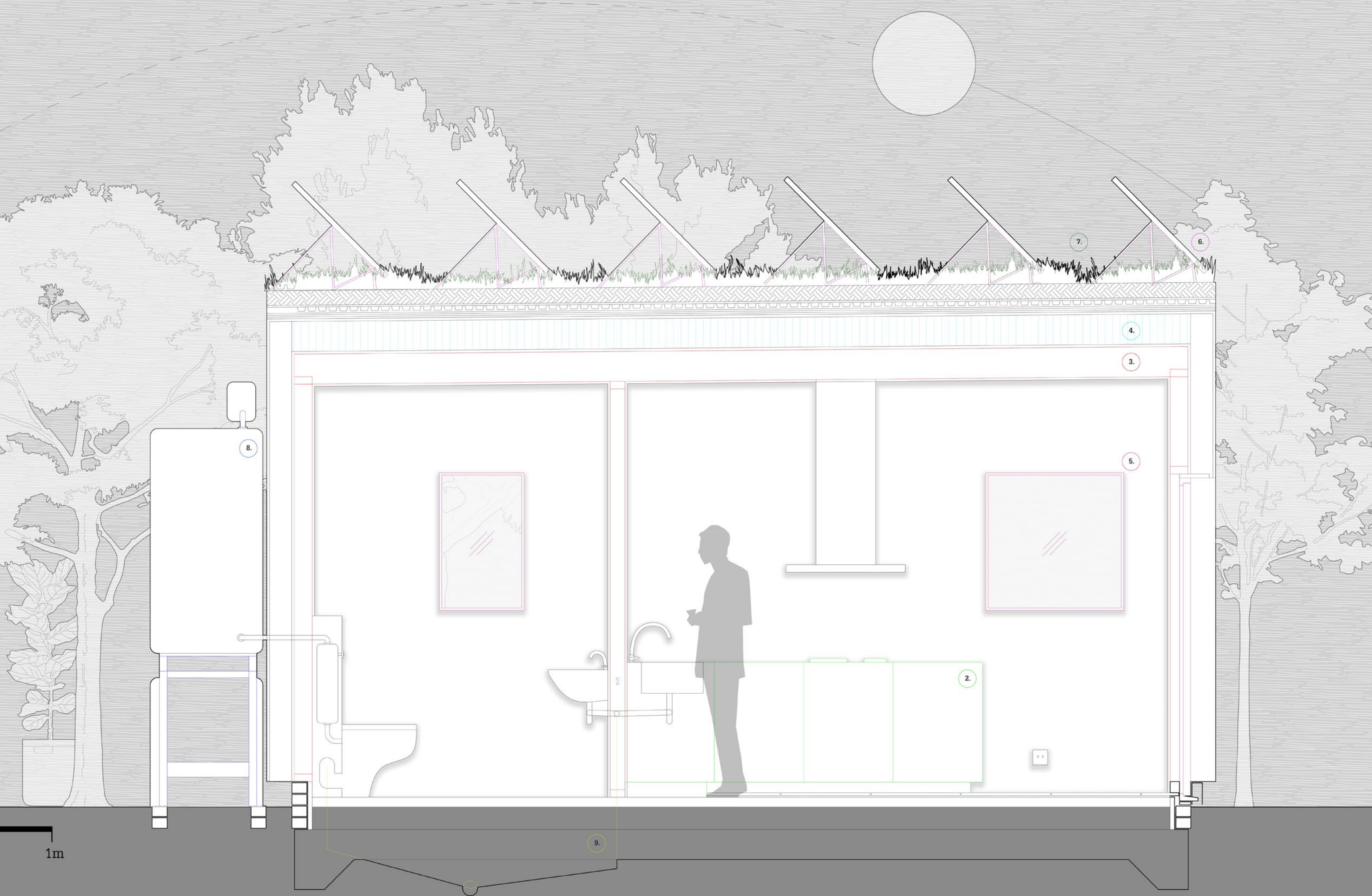
Knowing what materials are used today and will be used in the future, we're going to see how the Czech house will evolve over the years to become the Nexthouse.

# WHAT WOULD HAPPEN IF WE ONLY USE BIO-BASED MATERIALS?

# Evolution towards the Next House



# STEP 1 - 2023




1. Furniture (flex) - recyclable and renewable where possible wooden furniture with soft fabric
2. Furniture (fixed) - recyclable materials where it is possible
3. Structure - timber structure
4. Insulation - cork insulation
5. Openings - all windows and doors have timber frames, openings with layered glass
6. Power - system combined with solar panels added to the roof
7. Flora - extensive green roof
8. Water - system combined with rainwater tank which provides grey water
9. Waste - composting as much  waste as possible

10 Heat - not changed

11. Nutrition - not chnaged

12. Light - LED light

### STEP 0 – HOUSE OF TODAY

*Household efficiency for MATERIAL & SPACE.*

MATERIAL efficiency = 38.5%

SPACE efficiency = 16.2 ÷ 195.9
= 8.2%

Operational CO2 impact/day
= water + electricity + gas + waste + food + CO2 + O2
= 49 + 8.55+ 13.47 + 3.4 + 12.5 +56.7 + 55.38
= 199kg

Embodied CO2 impact/lifetime = 148 887.7kg

### STEP 1

***MATERIAL efficiency:** New implementation of wooden construction (80 years – 100% efficiency), insulation (cork 200 years – 50% efficiency) & solar panels (silicon 45 years – 56% efficiency).*

MATERIAL efficiency = **40%**

SPACE efficiency = 16.2 ÷ 195.9
= 8.2% *(same as STEP 0)*

Operational CO2 impact/day
= **water** + **electricity** + gas + **waste** + food + CO2 + O2
= **42** + **6.4** + 13.47 + **2.55** + 12.5 + *same* + *same*
= **188kg**

Embodied CO2 impact/lifetime = **131 199.7kg**

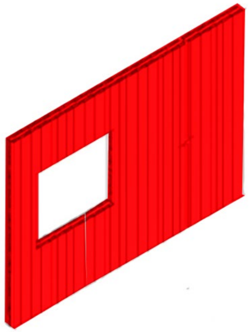
## STEP 1

SCALE 1:5

0 0.1 0.2 0.3 0.4 0.5 1m

# STEP 1 - Material efficiency

- Wooden panel/Wood

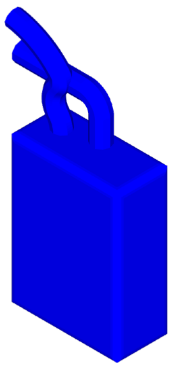


80 years
Usespan of element

100 years
Lifespan of material

**80%**
**Material Efficiency**

- Boiler/Steel

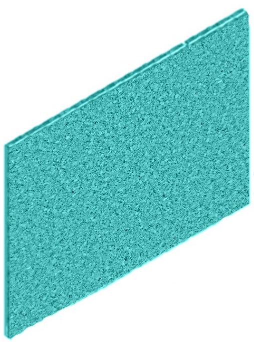


15 years
Usespan of element

100 years
Lifespan of material

**15%**
**Material Efficiency**

- Insulation/Cork

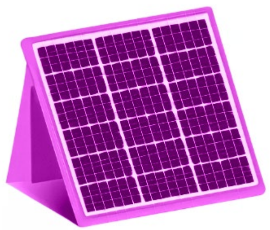


100 years
Usespan of element

200 years
Lifespan of material

**50%**
**Material Efficiency**

- Solar panel/Silicon



25 years
Usespan of element

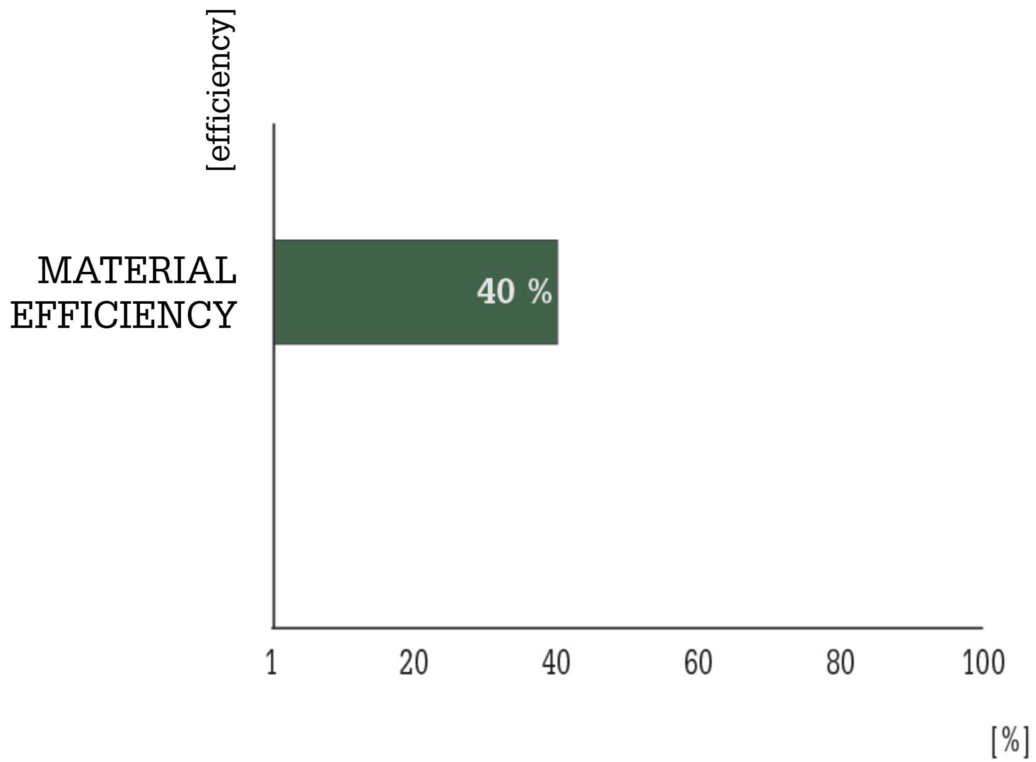
45 years
Lifespan of material

**56%**
**Material Efficiency**

[Source: Buildwithrise.com]

# STEP 1 - Common coin

## Household EFFICIENCY



## STEP 1 - Space efficiency

$$\frac{\text{16.2 m}^3\ \text{Space we need}}{\text{195.9 m}^3\ \text{Space we use}} = \text{8.2 \%}$$

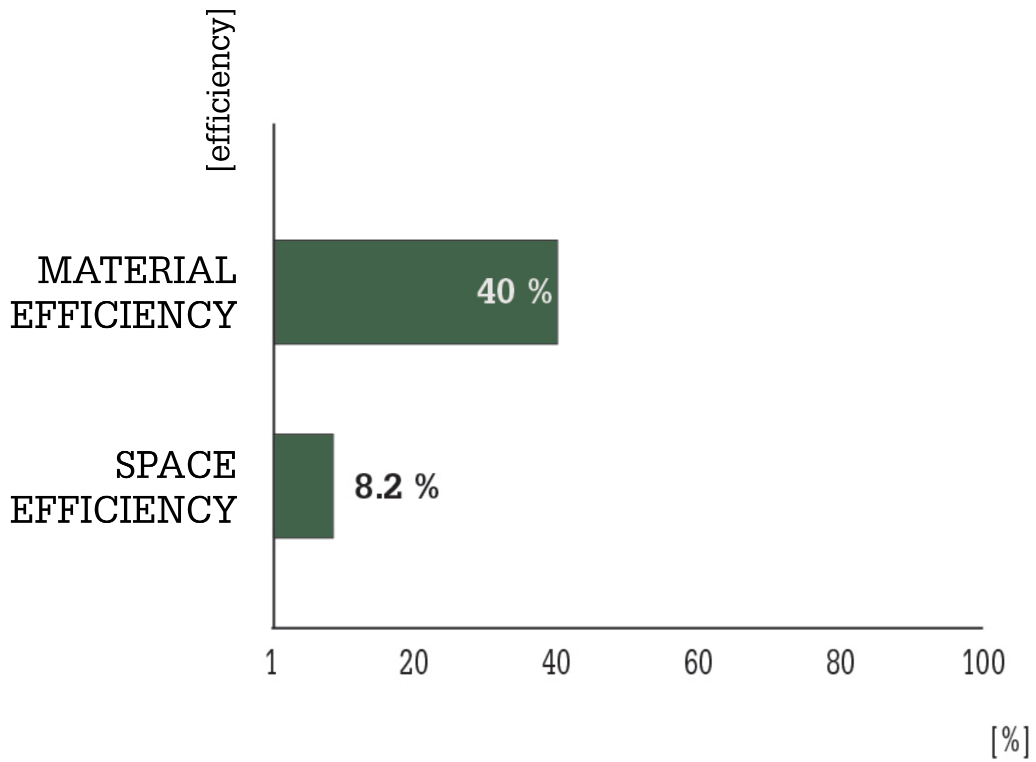
**16.2 m³** Space we need

**195.9 m³** Space we use

= **8.2 %** Household space efficiency

# STEP 1 - Common coin

## Household EFFICIENCY



# STEP 1 - Impact

## Operational $CO_2$ equivalent per day

| | | |
|---|---|---|
| Water | 42 kg | ~~49 kg~~ |
| Electricity | 6.4 kg | ~~8.55 kg~~ |
| Gas | 13.47 kg | |
| | ... | |

**Total:**

**188 kg**

## Embodied $CO_2$ equivalent per lifetime

| | |
|---|---|
| ~~Concrete~~ Wood | 1596 kg |
| ~~Textiles~~ Cork | 47.7 kg |
| ~~Granite~~ Silicon | 51.5 kg |
| | ... |

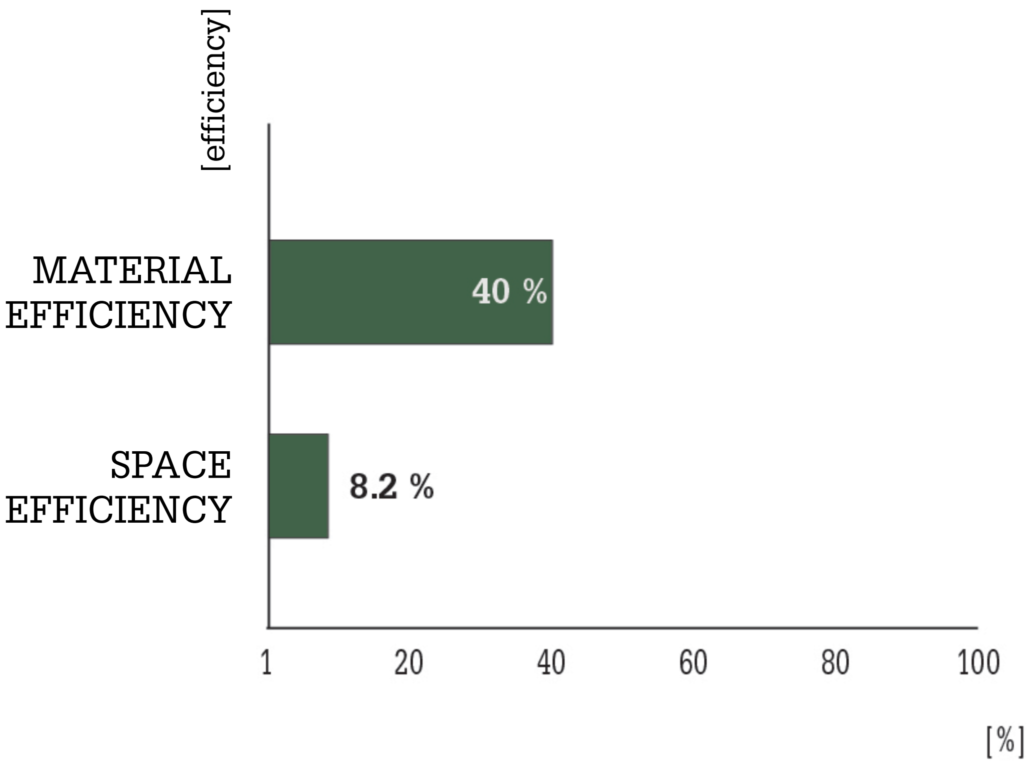
**Total:**

**131 199.6 kg**

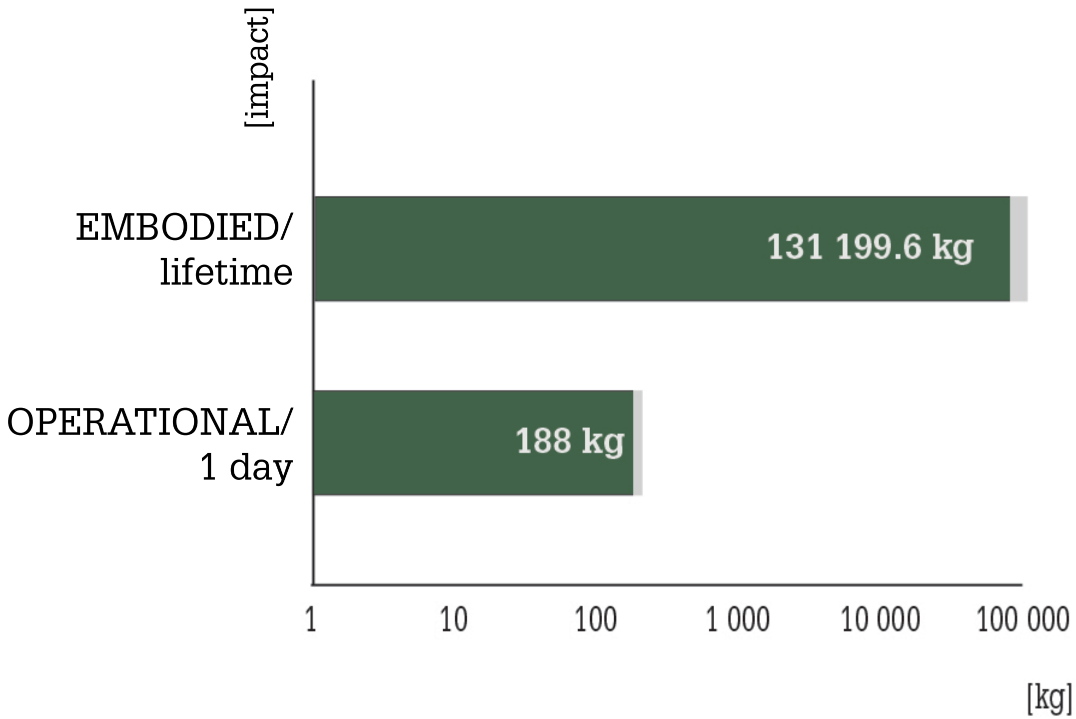
[Source: Buildwithrise.com]

# STEP 1 - Common coin

## Household EFFICIENCY



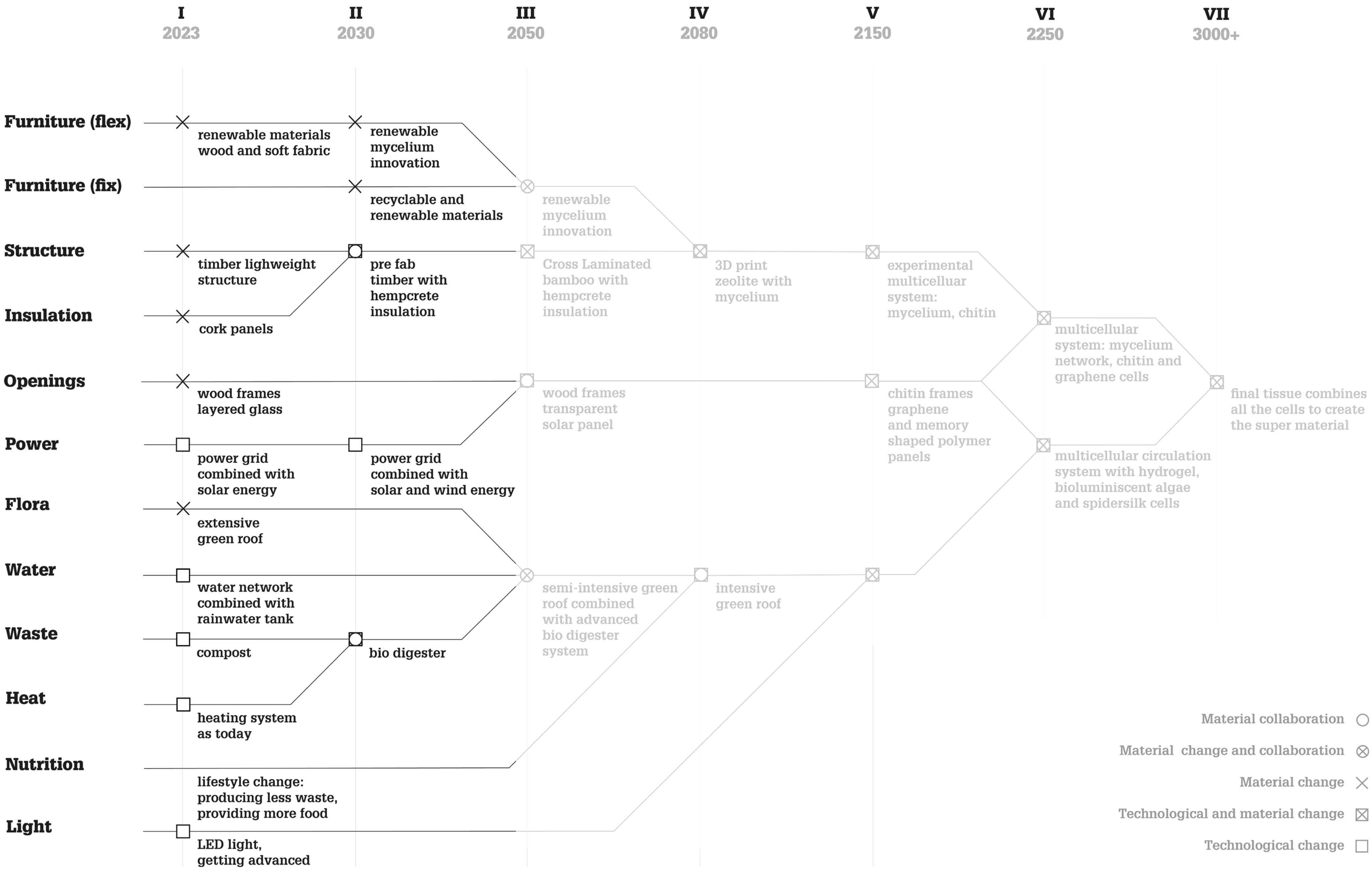

## Household IMPACT



# OUR IMPACT IS STILL TOO BIG AND OUR EFFICIENCY TOO LOW

# WHAT HAPPENS IF WE IMPROVE OUR EXISTING MATERIALS AND TECHNOLOGIES?

# Evolution towards the Next House



# 6.1 NEXT HOUSE IN CZECH REPUBLIC

# STEP 2 - 2030

1. Furniture (flex) - renewable mycelium furniture

2. Furniture (fixed) - made from recyclable materials mostly

3. Structure and insulation - prefabricated timber structure with hempcrete insulation inside

5. Openings - all windows and doors have timber frames, openings with layered glass

6. Power - system combined with solar panels and wind turbines added to the roof

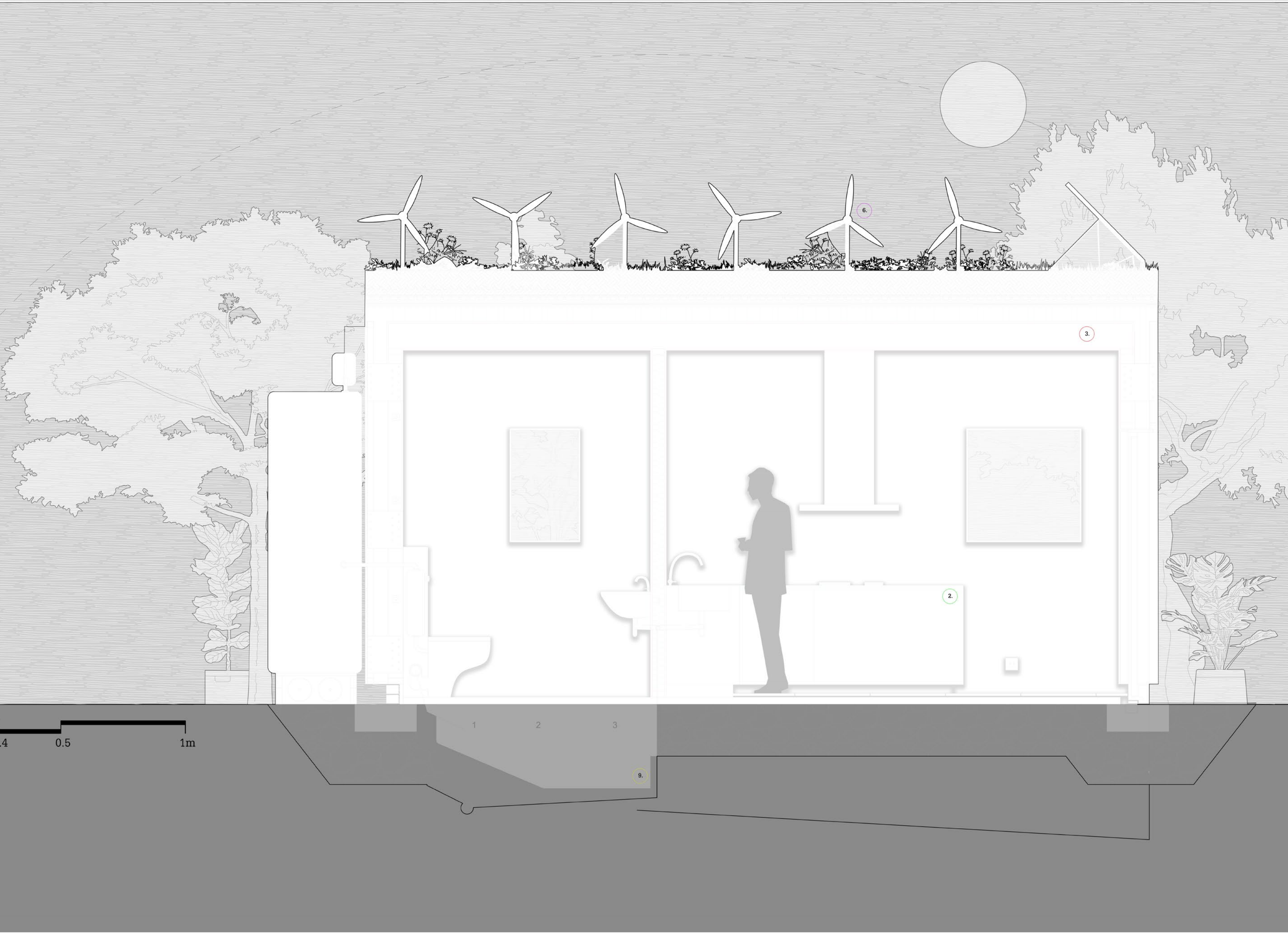
7. Flora - extensive green roof

8. Water - system combined with rainwater tank which provides grey water

9. Waste and Heat - biodigester turning waste into heating

11. Nutrition - not chnaged

12. Light - LED light




### STEP 2

***MATERIAL efficiency**: New implementation of hempcrete panels (100 years - 80% efficiency). Biodigester (recycled plastic 40 years – 50% efficiency), insulation (hempcrete 300 years – 40% efficiency) & chair (mycelium 20 years – 50% efficiency).*

MATERIAL efficiency = <u>40-50%</u>

SPACE efficiency = 16.2 ÷ 195.9
= 8.2% *(same as STEP 0)*

Operational CO2 impact/day
= water + **electricity** + **gas** + **waste** + food + CO2 + O2
= 42 + **3.8** + **9.4** + **1.8** + 12.5 + *same* + *same*
= <u>170kg</u>

Embodied CO2 impact/lifetime = <u>104 500kg</u>

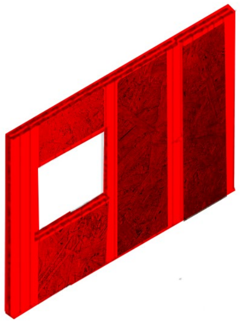
## STEP 2

SCALE 1:5

0 0.1 0.2 0.3 0.4 0.5 1m

# STEP 2 - Material efficiency

- Prefabricated wooden construction with hempcrete panels/Wood + Hempcrete



80 years
Usespan of element

100 years
Lifespan of material

**80% Material Efficiency**

- Biodigester/Recycled plactic

20 years
Usespan of element

40 years
Lifespan of material

**50% Material Efficiency**

- Insulation/Hempcrete

120 years
Usespan of element

300 years
Lifespan of material

**40% Material Efficiency**

- Chair/Mycelium

10 years
Usespan of element

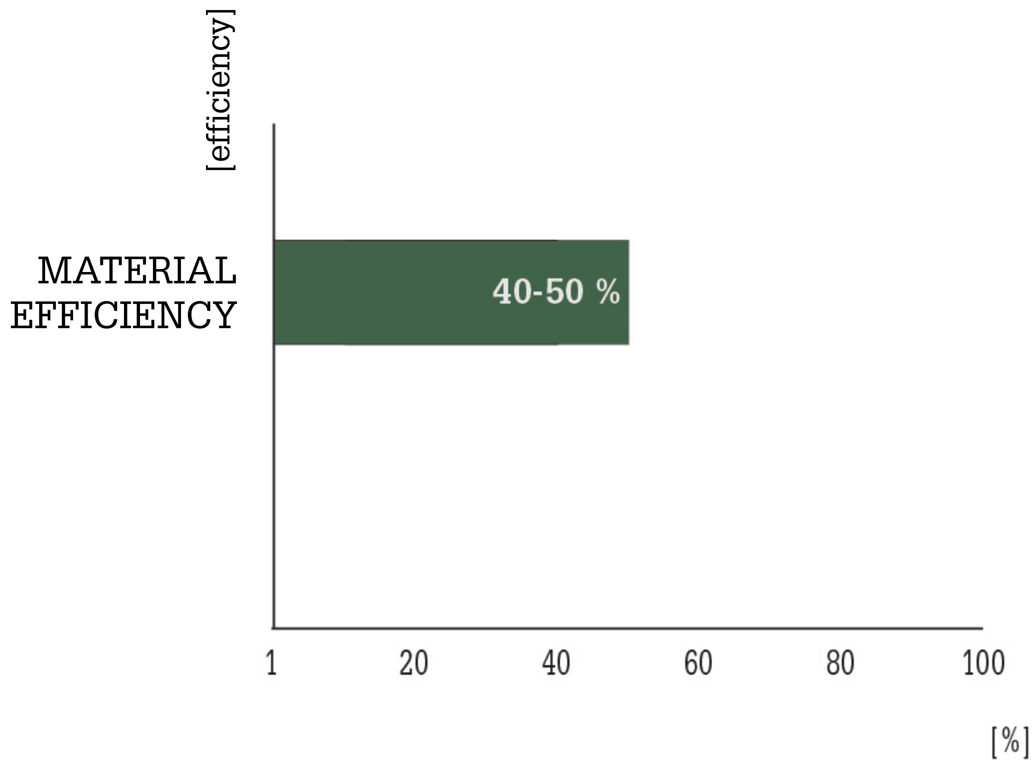
20 years
Lifespan of material

**50% Material Efficiency**

[Source: Weber-tradical.com]

# STEP 2 - Common coin

## Household EFFICIENCY



## STEP 2 - Space efficiency

$$\frac{16.2\ m^3 \text{ (Space we need)}}{195.9\ m^3 \text{ (Space we use)}} = 8.2\ \% \text{ (Household space efficiency)}$$

**16.2 m³**
**Space we need**

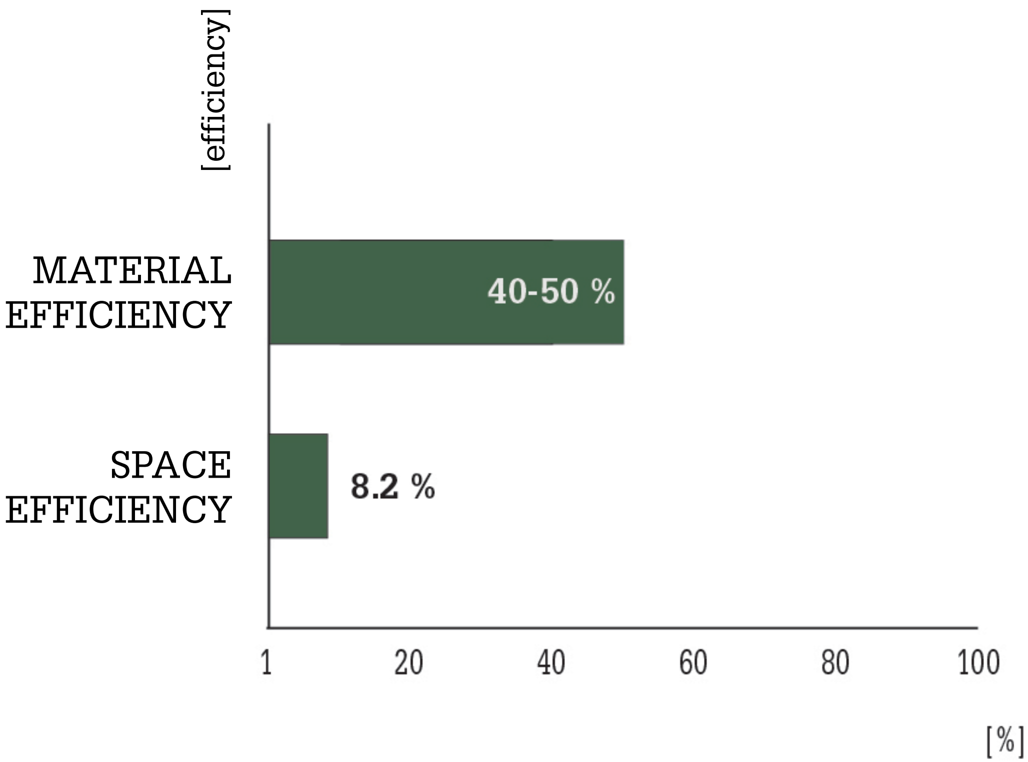
**195.9 m³**
**Space we use**

=

**8.2 %**
**Household space efficiency**

# STEP 2 - Common coin

## Household EFFICIENCY



# STEP 2 - Impact

## Operational $CO_2$ equivalent per day

| | | |
|---|---|---|
| Water | 42 kg | |
| Electricity | 3.8 kg | ~~6.4 kg~~ |
| Gas | 9.4 kg | ~~13.47 kg~~ |
| | ... | |

**Total:**
**170 kg**

## Embodied $CO_2$ equivalent per lifetime

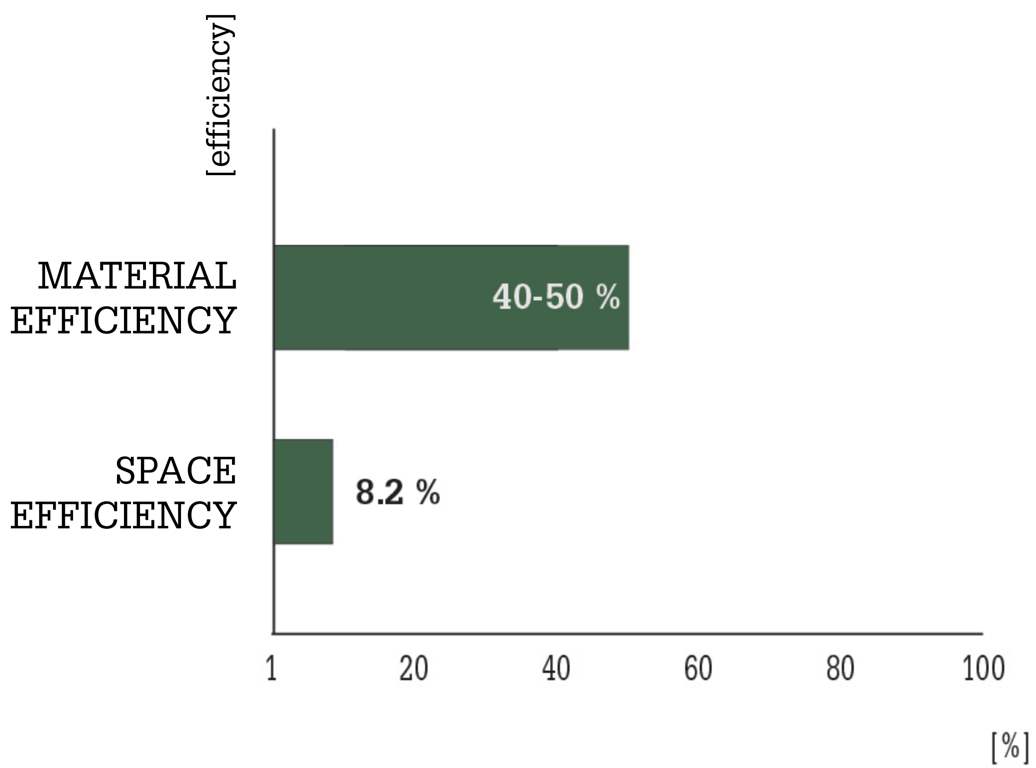
| | | |
|---|---|---|
| Wood | 1350 kg | ~~1596 kg~~ |
| ~~Cork~~ Hempcrete | 40 kg | |
| ~~Silicon~~ Mycelium | 36.5 kg | |
| | ... | |

**Total:**
**104 500 kg**

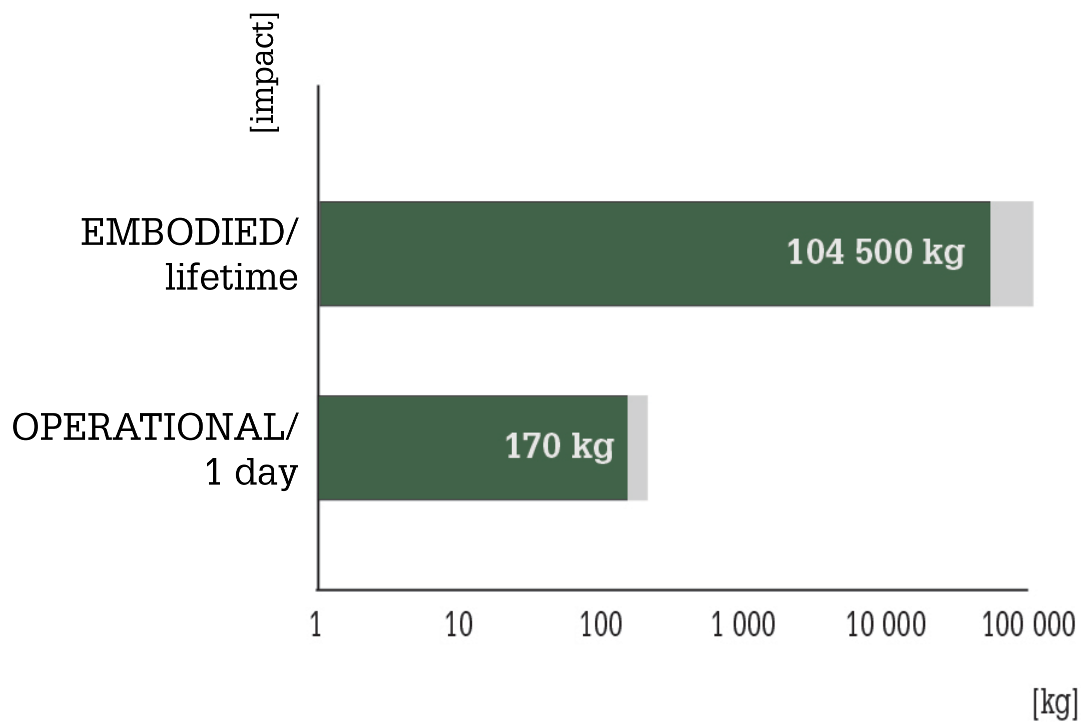
[Source: Weber-tradical.com]

# STEP 2 - Common coin

## Household EFFICIENCY

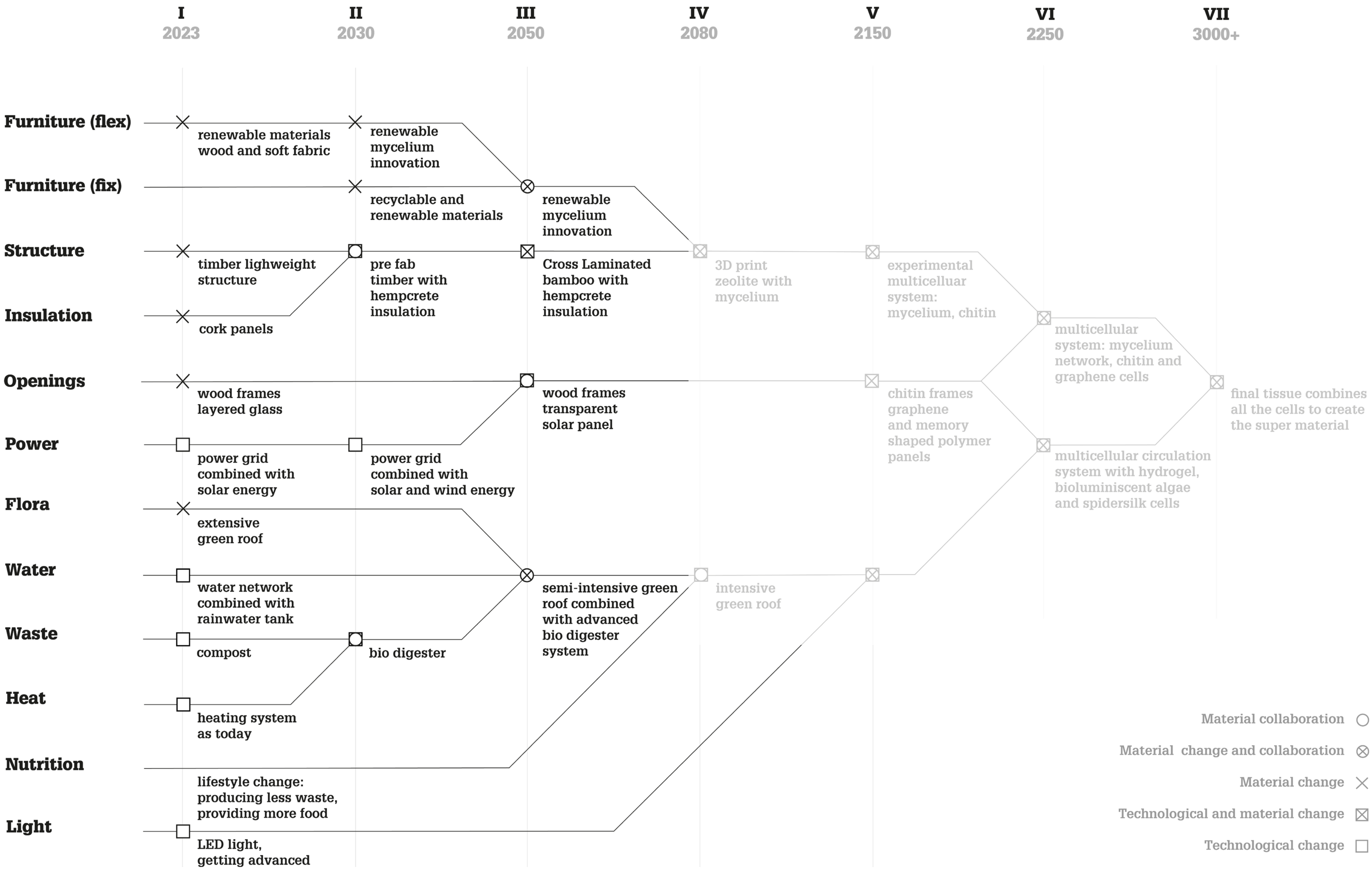



## Household IMPACT



# LET'S GO A STEP FURTHER

# Evolution towards the Next House



# STEP 3 - 2050

1. Furniture (flex and fixed) - renewable mycelium furniture innovation where possible

3. Structure and insulation - Cross Laminated Bamboo with hempcrete insulation

5. Openings and Power - all windows and doors have timber frames, openings with transparent solar panels

8. Flora, Water, Waste and Heat - semi-intensive green roof in one system with the biodigester what consumes waste and provides heating

11. Nutrition - not chnaged

12. Light - LED light


### STEP 3

***MATERIAL efficiency:*** *New implementation of CL bamboo (bamboo 80 years – 100% efficiency). Biodigester (fiberglass 50 years – 60% efficiency) & transparent solar panels (perovskites 35 years – 71% efficiency).*

MATERIAL efficiency = <u>50-60%</u>

SPACE efficiency = 16.2 ÷ **158.7**
= <u>11%</u>

Operational CO2 impact/day
= **water** + **electricity** + gas + **waste** + **food** + CO2 + O2
= **36.1** + **1.9** + 9.4 + **1.5** + **8.6** + *same* + *same*
= <u>144 kg</u>

Embodied CO2 impact/lifetime = <u>82 720kg</u>

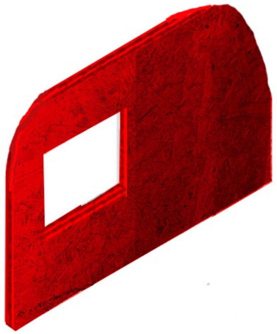
## STEP 3

SCALE 1:5

0 0.1 0.2 0.3 0.4 0.5 1m

# STEP 3 - Material efficiency

- CL bamboo with hempcrete panels/Bamboo



100 years
Usespan of element

100 years
Lifespan of material

**100%**
**Material Efficiency**

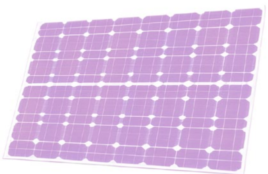
- Biodigester/Fiberglass

30 years
Usespan of element

50 years
Lifespan of material

**60%**
**Material Efficiency**

- Transparent solar panels/Perovskites



25 years
Usespan of element

35 years
Lifespan of material

**71%**
**Material Efficiency**

- Chair/Mycelium

10 years
Usespan of element

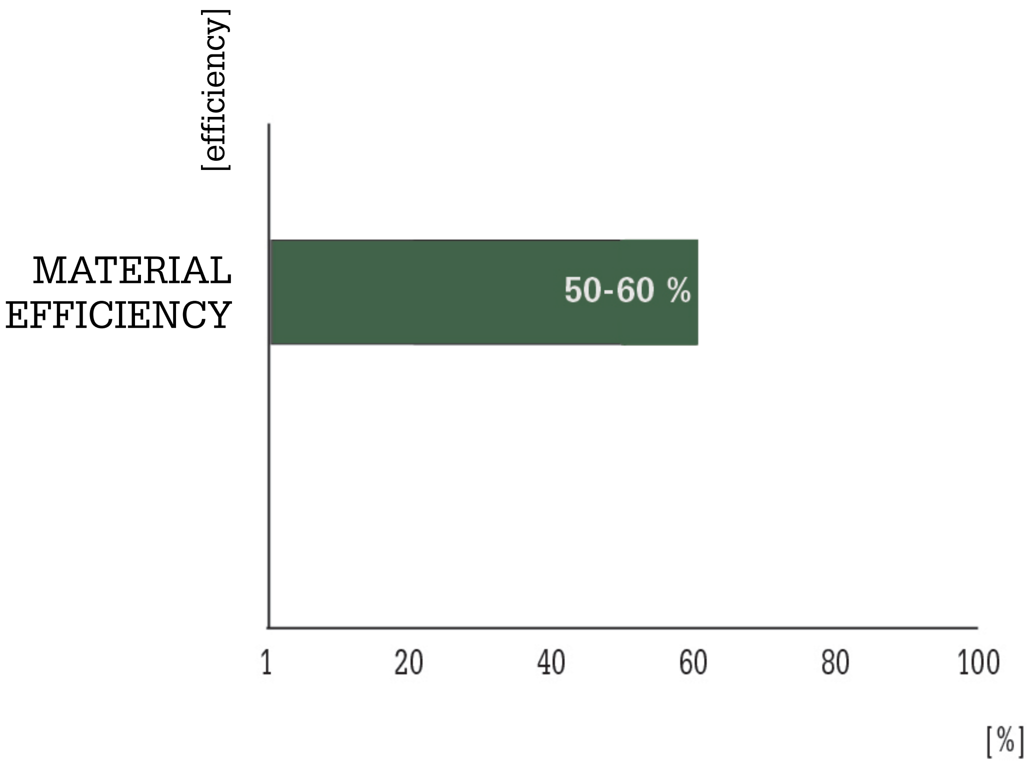
20 years
Lifespan of material

**50%**
**Material Efficiency**

[Source: Weforum.org]

# STEP 3 - Common coin

## Household EFFICIENCY



## STEP 3 - Space efficiency

$$\frac{16.2\ m^3 \text{ Space we need}}{158.7\ m^3 \text{ Space we use}} = 11\%$$

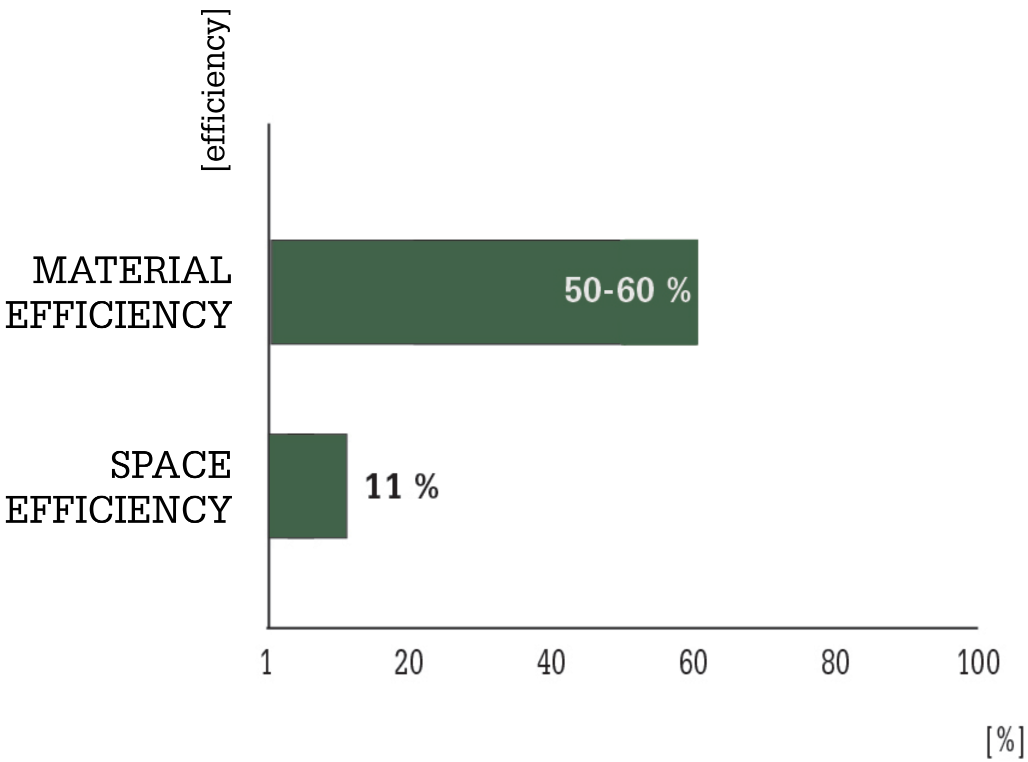
**16.2 m³** Space we need

**158.7 m³** Space we use

= **11%** Household space efficiency

# STEP 3 - Common coin

## Household EFFICIENCY



# STEP 3 - Impact

## Operational $CO_2$ equivalent per day

| | | |
|---|---|---|
| Water | 36.1 kg | ~~42 kg~~ |
| Electricity | 1.9 kg | ~~3.8 kg~~ |
| Gas | 9.4 kg | |
| | ... | |

**Total:**

**144 kg**

## Embodied $CO_2$ equivalent per lifetime

| | | |
|---|---|---|
| ~~Wood~~ Bamboo | 1220 kg | |
| Hempcrete | 32 kg | ~~40 kg~~ |
| Mycelium | 28.5 kg | ~~36.5 kg~~ |
| | ... | |

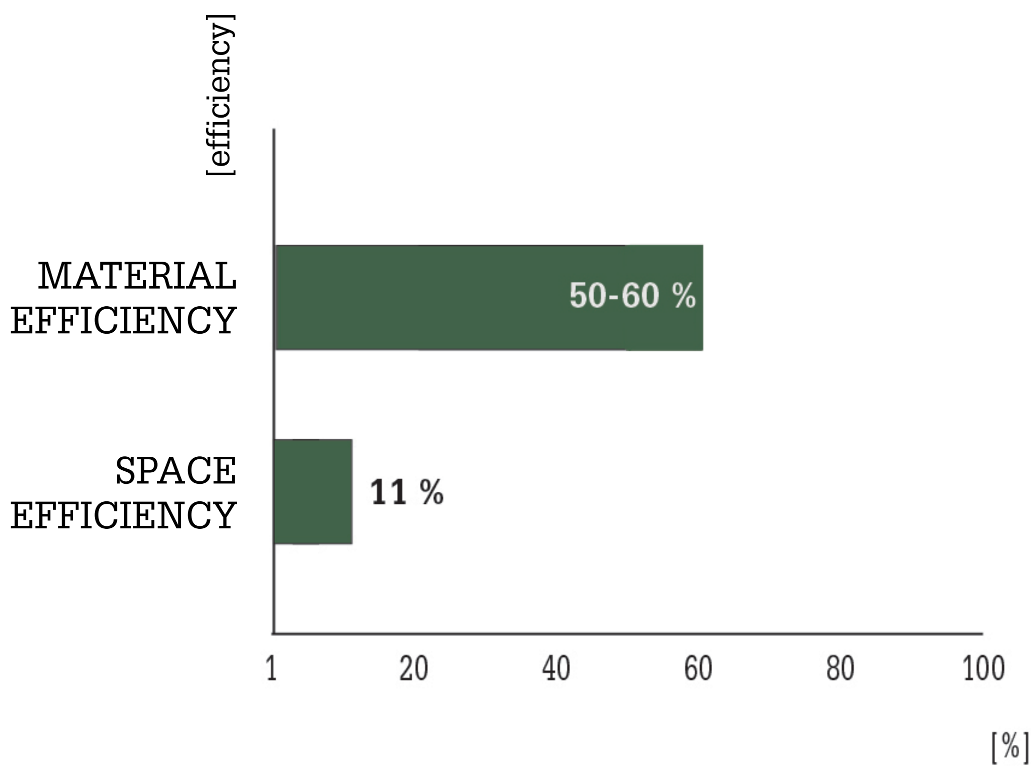
**Total:**

**87 720 kg**

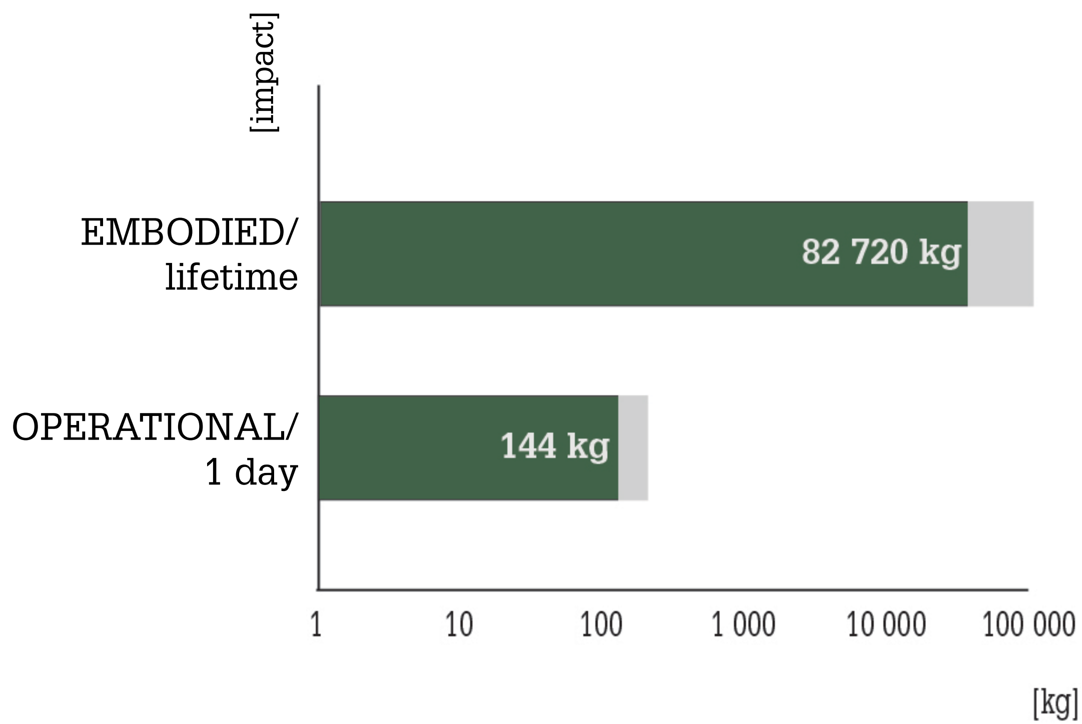
[Source: Weforum.org]

# STEP 3 - Common coin

## Household EFFICIENCY

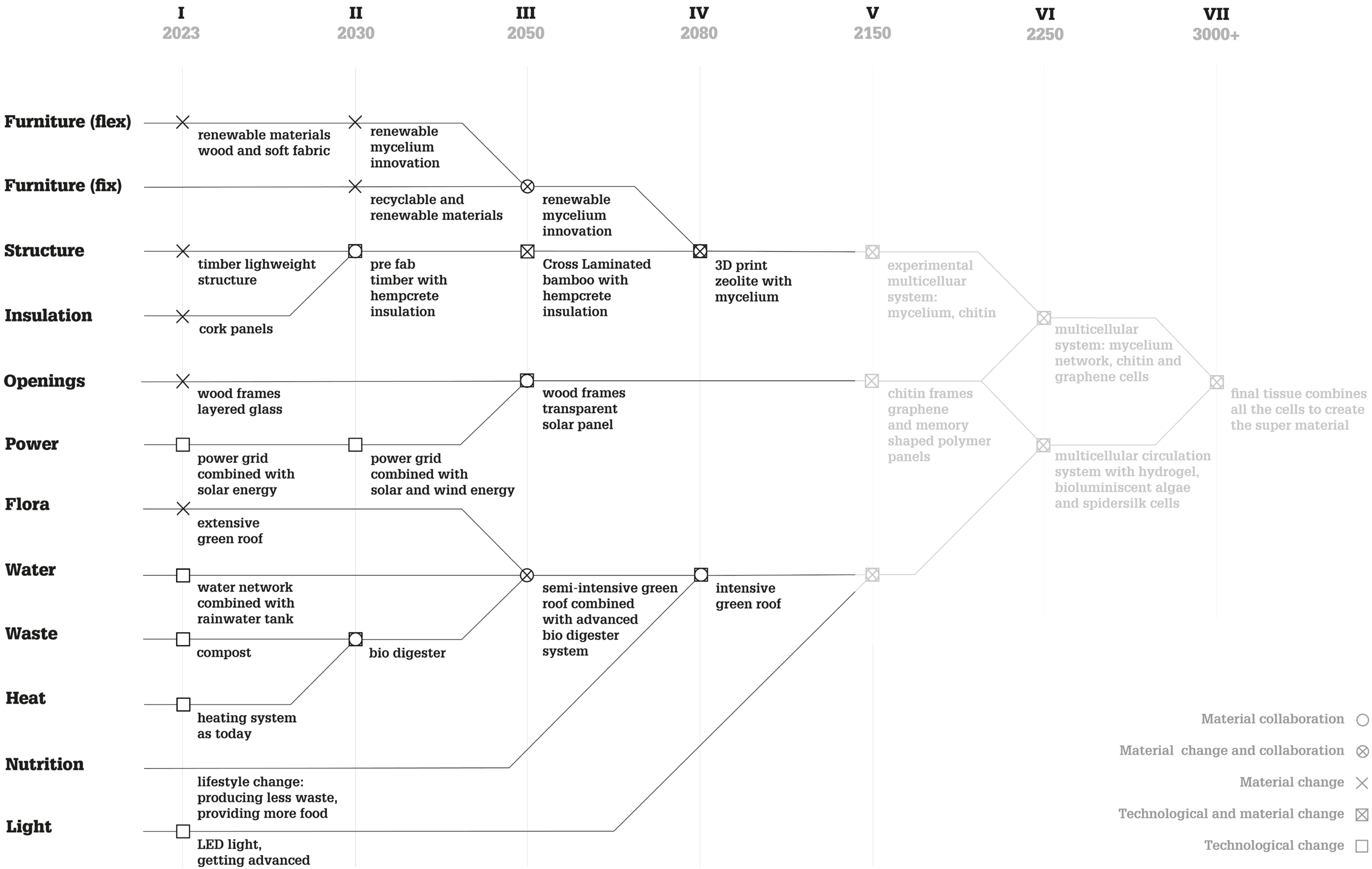



## Household IMPACT



# FURTHER IMPROVEMENT IN THE MATERIALS AND TECHNOLOGIES WE USE?

# Evolution towards the Next House



# 6.1 NEXT HOUSE IN THE CZECH REPUBLIC

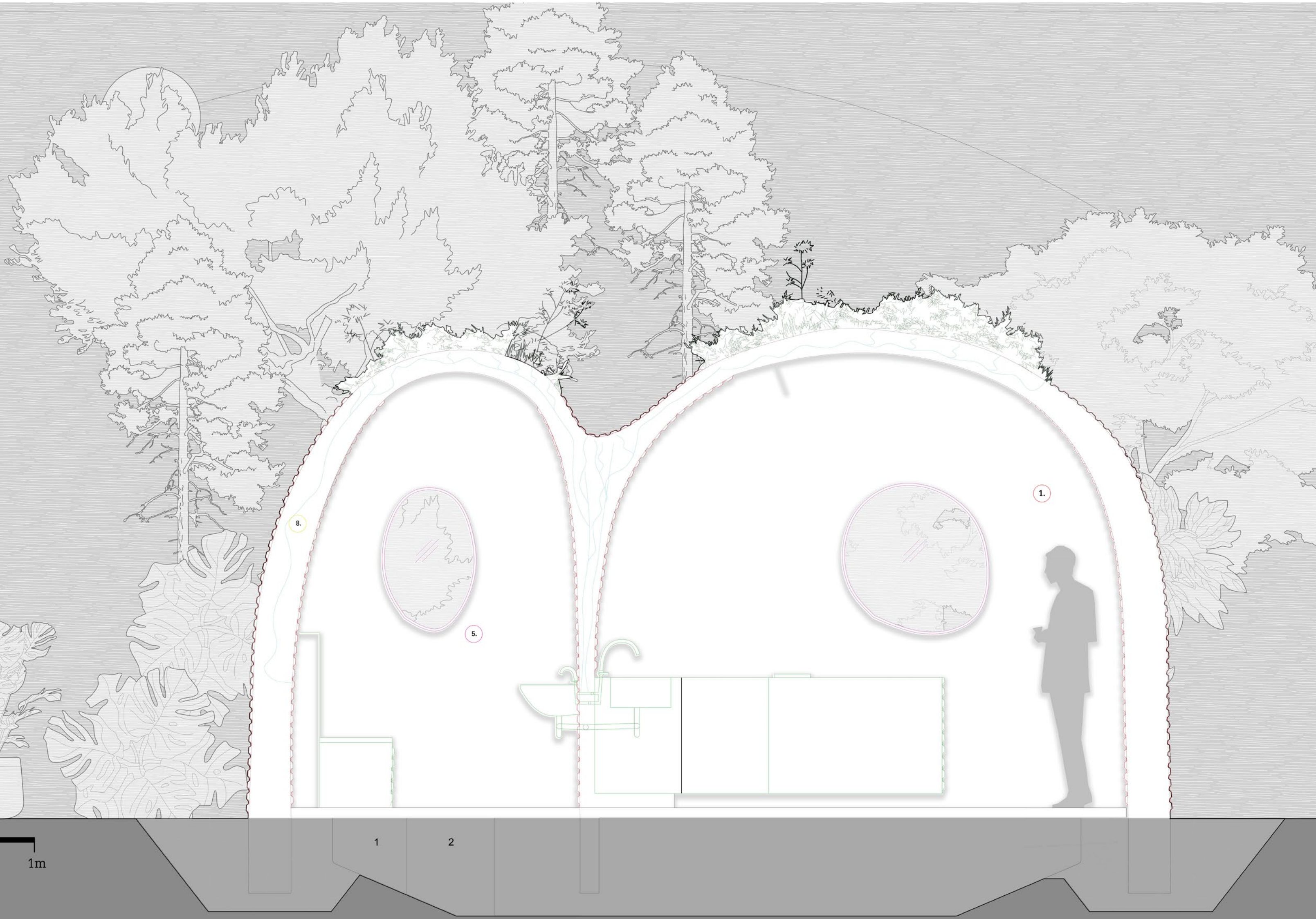
# STEP 4 - 2080

1. Furniture (flex and fixed), Structure and Insulation
   - 3D printed zeolite and mycelium structure and insulation
   - 3D printed furnitures

5. Openings and Power
   - all windows and doors have timber frames, openings with transparent solar panels

8. Flora, Water, Waste, Heat and Nutrition
   - intensive green roof in one system with the developed biodigester system what consumes waste and provides heating
   - own vegetation on the roof provides nutrition

12. Light - LED light




### STEP 4

***MATERIAL efficiency**: New implementation of 3D printed wall (mycelium with zeolite 150 years – 100% efficiency), Biodigester (polymers 55 years – 64% efficiency) & chair (mycelium with zeolite 150 years – 100% efficiency).*

MATERIAL efficiency = <u>60-70%</u>

SPACE efficiency = 16.2 ÷ 84
= <u>19%</u>

Operational CO2 impact/day
= water + electricity + gas + waste + food + CO2 + O2
= 20 + 1 + 5.4 + 1 + 5 + *same* + *same*
= <u>85kg</u>

Embodied CO2 impact/lifetime = <u>48 220kg</u>

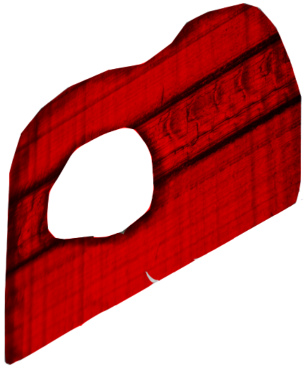
## STEP 4

SCALE 1:5

0 0.1 0.2 0.3 0.4 0.5 1m

# STEP 4 - Material efficiency

- 3D printed wall/Mycelium + Zeolite



150 years
Usespan of element

150 years
Lifespan of material

**100%**
**Material Efficiency**

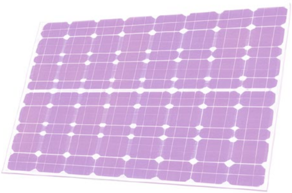
- Biodigester/Polimeres

35 years
Usespan of element

55 years
Lifespan of material

**64%**
**Material Efficiency**

- Transparent solar panels/Perovskites

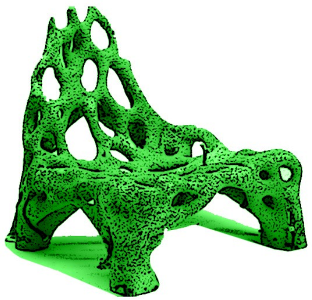


25 years
Usespan of element

35 years
Lifespan of material

**71%**
**Material Efficiency**

- Chair/Mycelium + Zeolite



150 years
Usespan of element

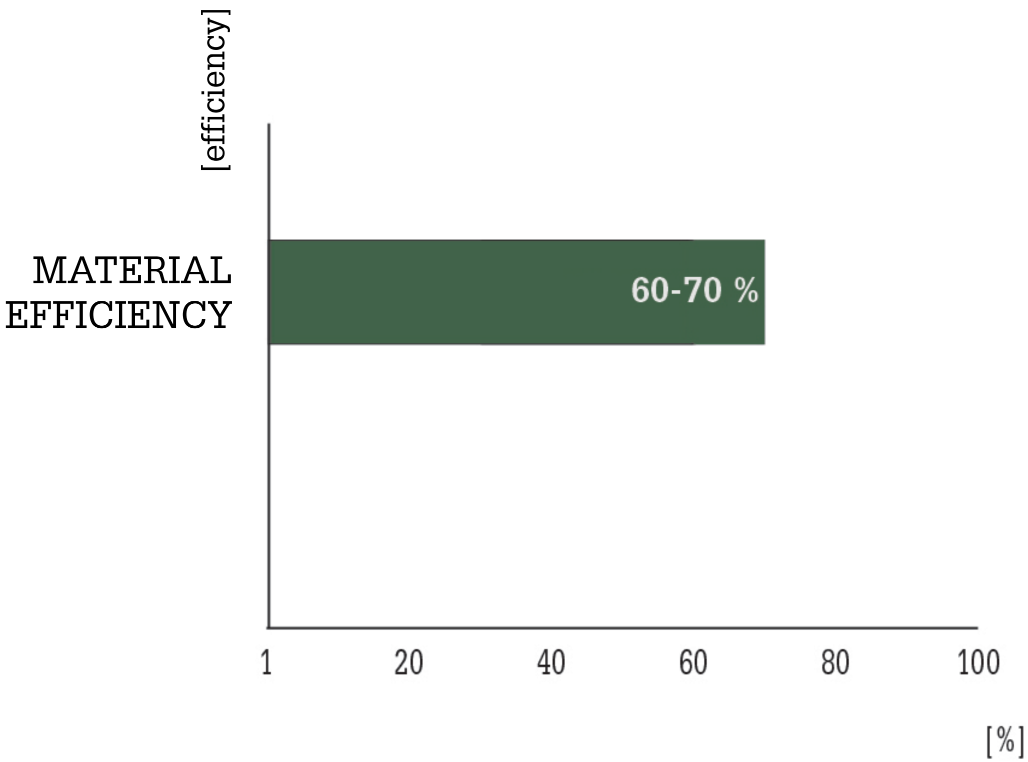
150 years
Lifespan of material

**100%**
**Material Efficiency**

[Source: Surfacesinternational.com]

# STEP 4 - Common coin

## Household EFFICIENCY



## Space efficiency – Step 4

$$\frac{16.2\ m^3 \text{ Space we need}}{84\ m^3 \text{ Space we use}} = 19\%$$

**16.2 m³**
**Space we need**

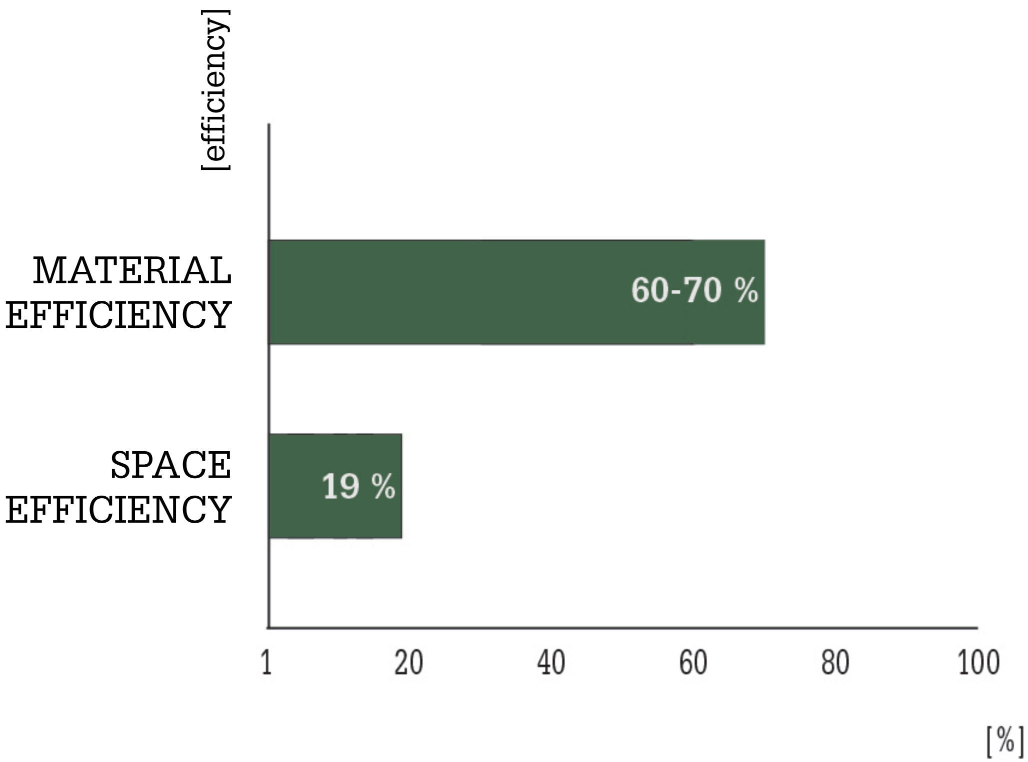
**84 m³**
**Space we use**

=

**19%**
**Household space efficiency**

# STEP 4 - Common coin

## Household EFFICIENCY



# STEP 4 - Impact

## Operational $CO_2$ equivalent per day

| | | |
|---|---|---|
| Water | 20 kg | ~~36.1 kg~~ |
| Electricity | 1 kg | ~~1.9 kg~~ |
| Gas | 5.4 kg | ~~9.4 kg~~ |
| | ... | |

**Total:**

**85 kg**

## Embodied $CO_2$ equivalent per lifetime

| | | |
|---|---|---|
| Mycelium | 15 kg | ~~28.5 kg~~ |
| ~~Bamboo~~ Polymeres | 40 kg | |
| ~~Hemprete~~ Zeolite | 15 kg | |
| | ... | |

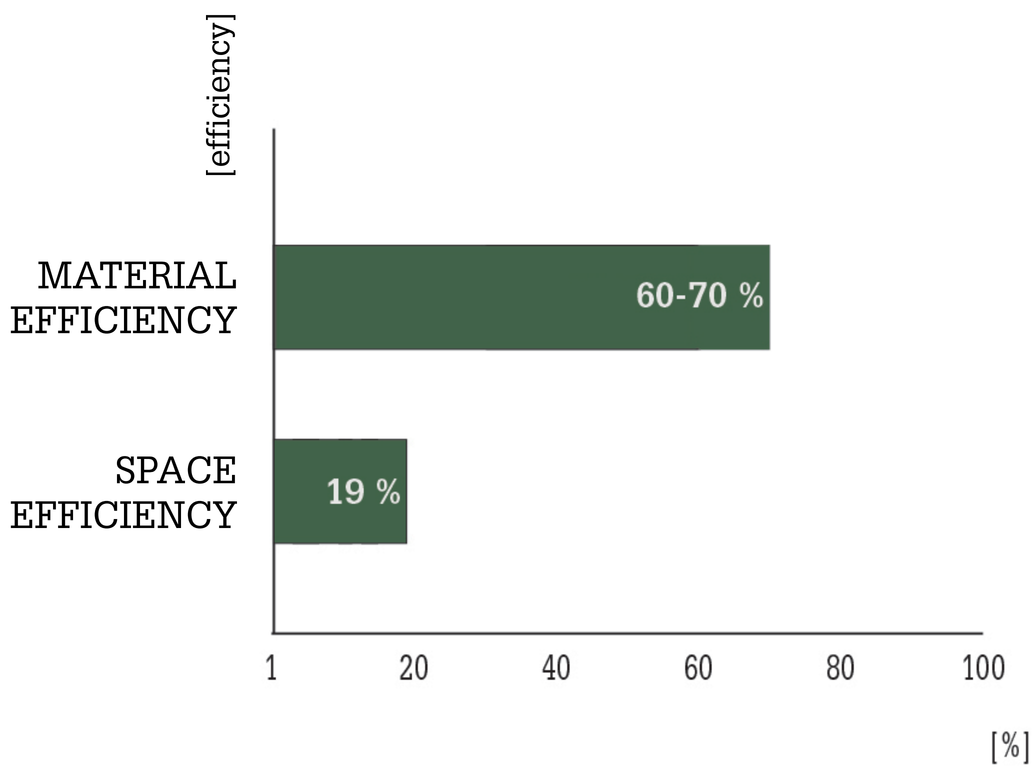
**Total:**

**48 220 kg**

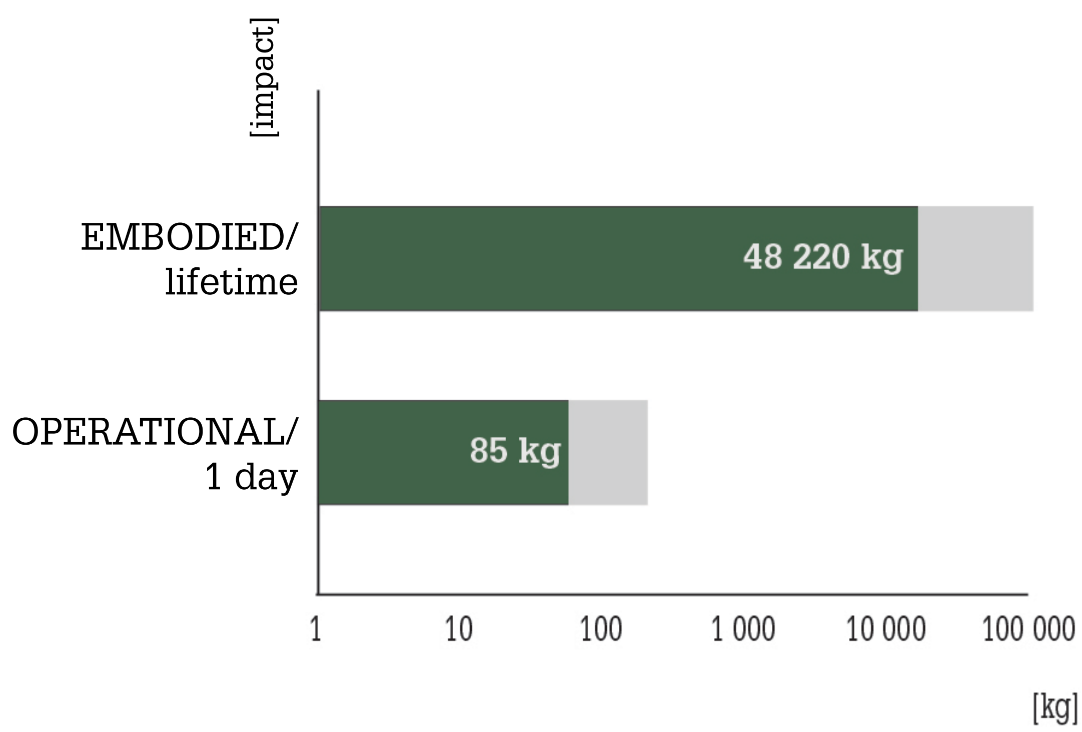
[Source: Surfacesinternational.com]

# STEP 4 - Common coin

## Household EFFICIENCY



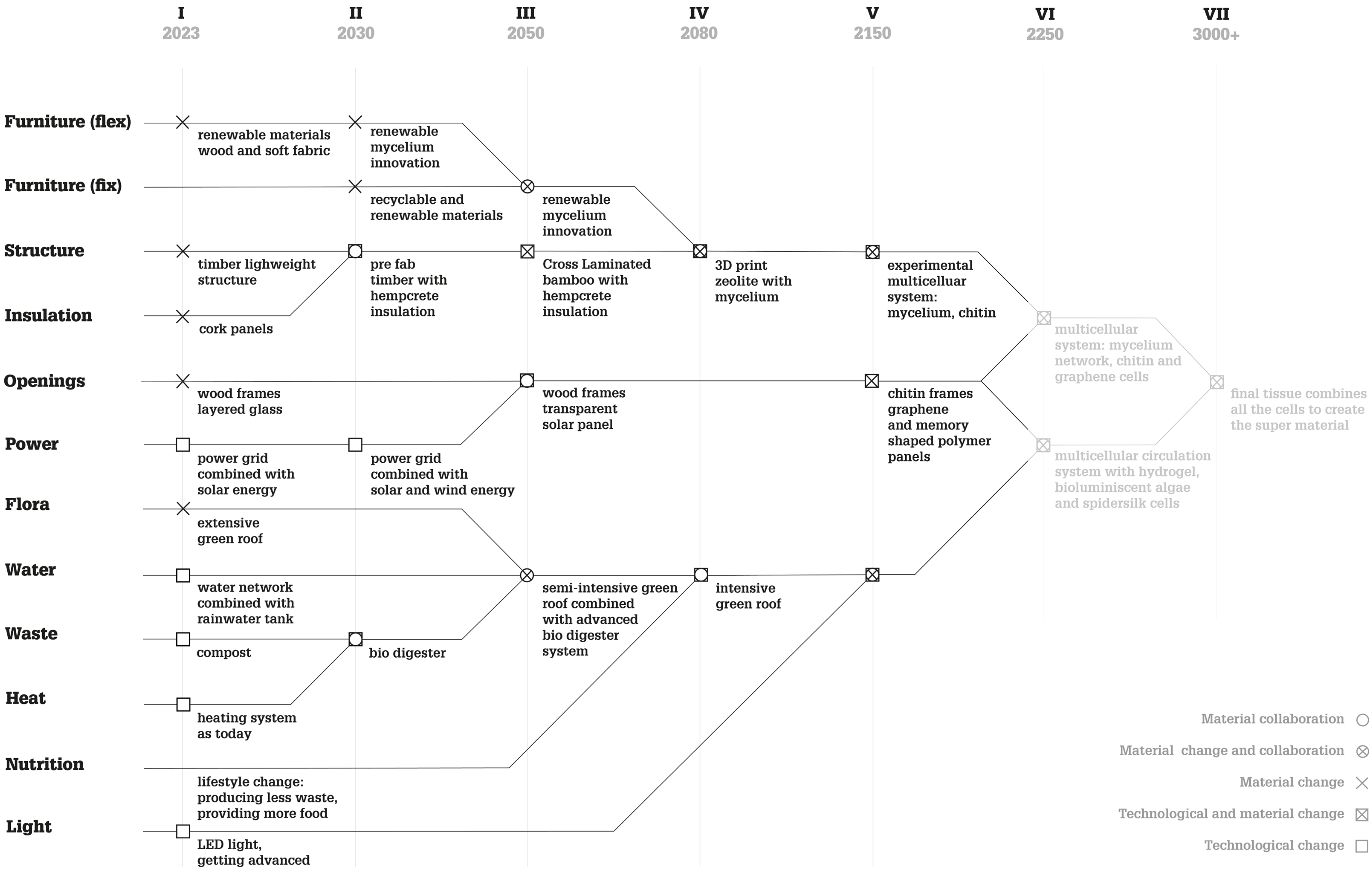

## Household IMPACT



# AS TIME GOES BY, NEW BUILDING TECHNOLOGIES EMERGE

# WE CAN REDUCE OUR IMPACT EVEN FURTHER THAN THIS AND IMPROVE OUR EFFICIENCY

# Evolution towards the Next House



# STEP 5 - 2150


1. Furniture (flex and fixed), Structure and Insulation
    - experimenting with multicellular system which is a collaboration of chitin structure and mycelium insulation
    - flexibility: mycelium with memory shaped polymers

5. Openings and Power
    - all windows and doors have chitin frames,
    - instead of transparent solar panels graphene, mycelium and memory shaped polymers
    - openings are flexible such as the structure

8. Flora, Water, Waste, Heat, Nutrition and Light
    - circulating system which is a collaboration of mycelium, bioluminescent algae, hydrogel

### STEP 5

***MATERIAL efficiency:*** *New implementation of multicellular wall (mycelium & chitin 300y – 100% eff.), circulation system (algae 80y – 75% eff.), chair (with chitin 300y – 100 % eff.) & transparent solar tissue (graphene & memory-shaped polymer 200y – 75% eff.).*

MATERIAL efficiency = 70-80%

SPACE efficiency = 16.2 ÷ 43
= 38%

Operational CO2 impact/day
= water + **electricity** + gas + **waste** + **food** + CO2 + O2
= 20 + 0 + 5.4 + 0 + 2 + *same* + *same*
= 40kg

Embodied CO2 impact/lifetime = 25 500kg

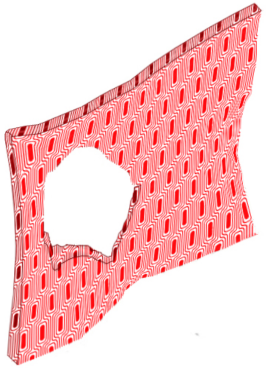
## STEP 5

SCALE 1:5

0 0.1 0.2 0.3 0.4 0.5m

# STEP 5 - Material efficiency

- Multi-cellular wall/Mycelium + Chitin



300 years
Usespan of element

300 years
Lifespan of material

→ **100%** **Material Efficiency**

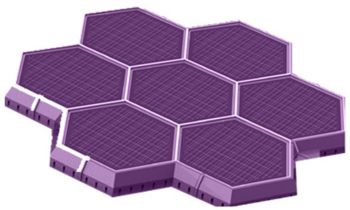
- Circulation system/Algae

60 years
Usespan of element

80 years
Lifespan of material

→ **75%** **Material Efficiency**

- Transparent solar tissue/
  Graphene + Memor-shaped polymeres

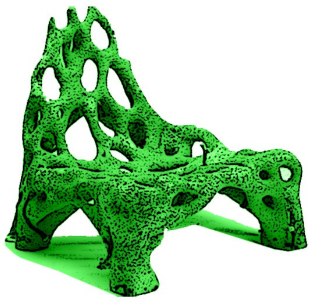


150 years
Usespan of element

200 years
Lifespan of material

→ **75%** **Material Efficiency**

- Chair/Mycelium + Chitin + Spidersilk



300 years
Usespan of element

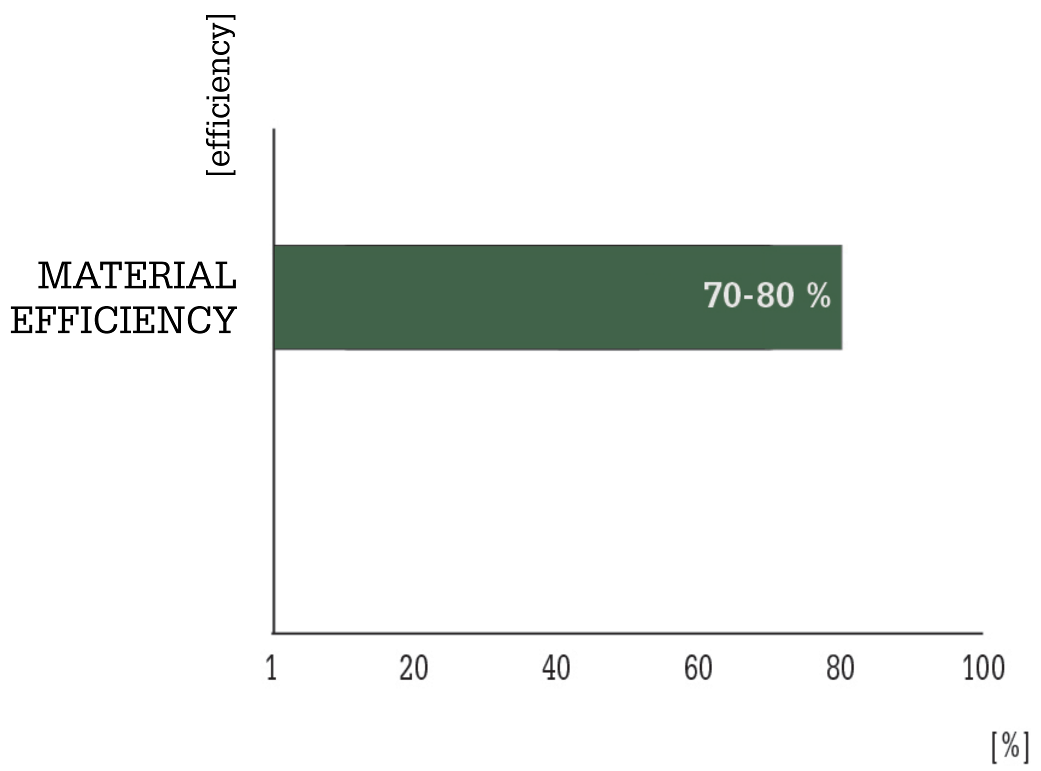
300 years
Lifespan of material

→ **100%** **Material Efficiency**

[Source: Architizer.com]

# STEP 5 - Common coin

## Household EFFICIENCY

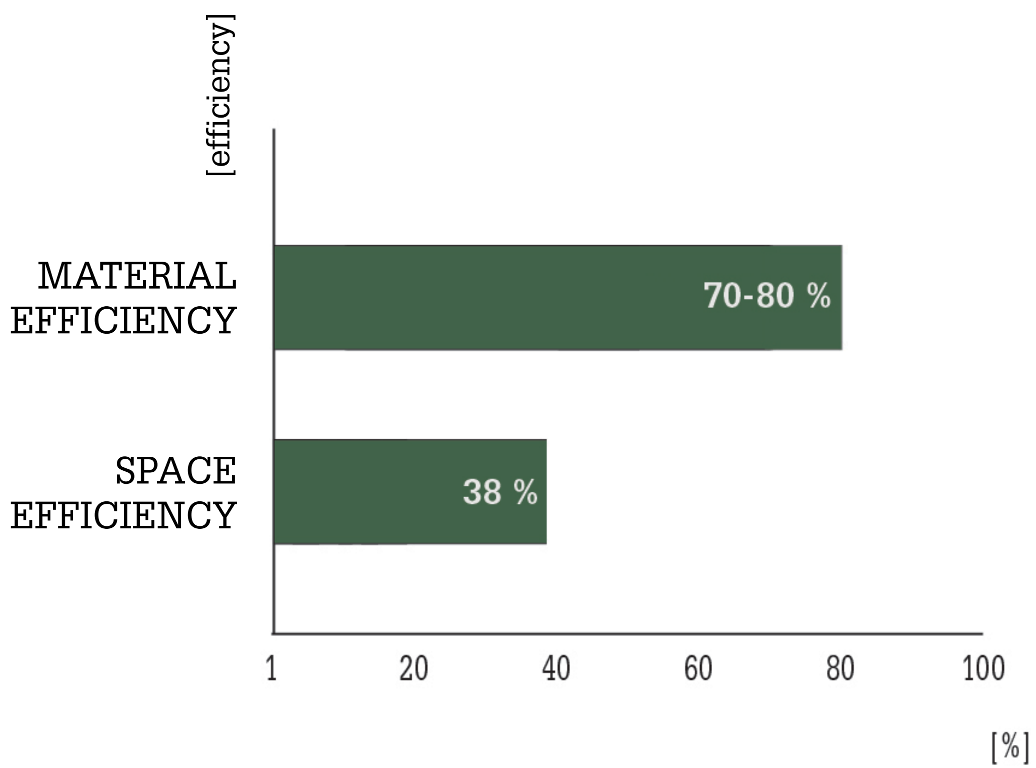


## STEP 5 - Space efficiency

$$\frac{16.2\ m^3 \text{ Space we need}}{43\ m^3 \text{ Space we use}} = 38\% \text{ Household space efficiency}$$

# STEP 5 - Common coin

## Household EFFICIENCY



# STEP 5 - Impact

## Operational $CO_2$ equivalent per day

| | | |
|---|---|---|
| Water | 10 kg | ~~20 kg~~ |
| Electricity | 0 kg | ~~1 kg~~ |
| Gas | 5.4 kg | |
| | ... | |

**Total:**
**40 kg**

## Embodied $CO_2$ equivalent per lifetime

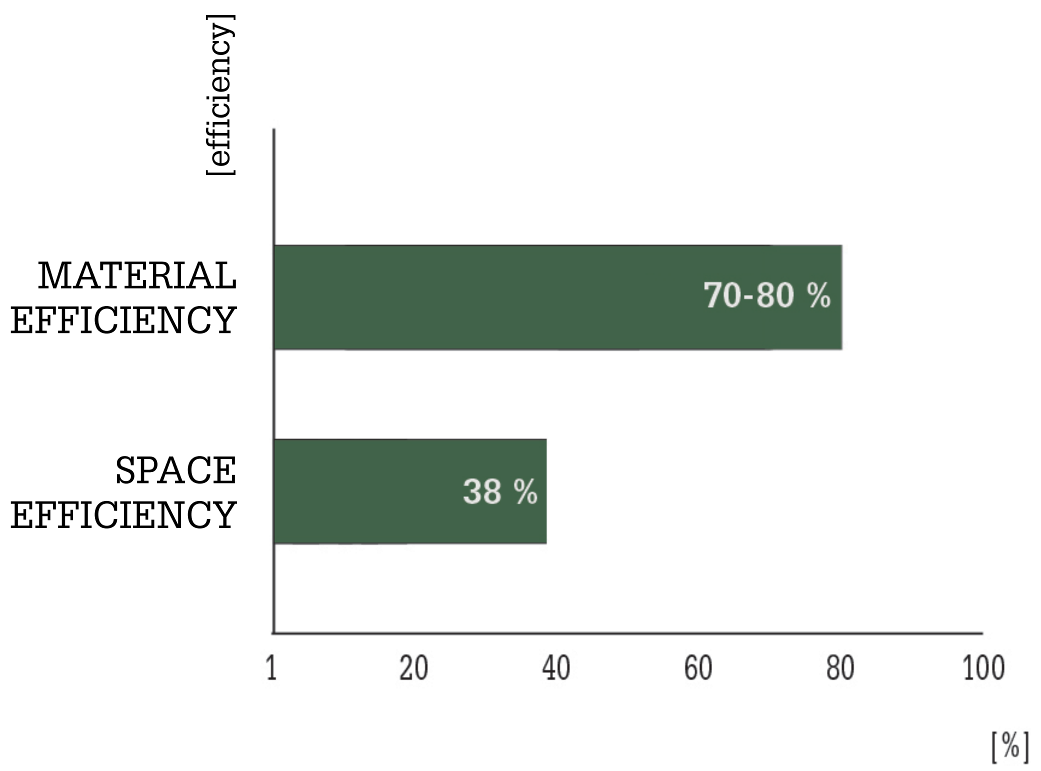
| | | |
|---|---|---|
| Mycelium | 9 kg | ~~15 kg~~ |
| Polymeres | 31 kg | ~~40 kg~~ |
| ~~Zeolite~~ Chitin | 10 kg | |
| | ... | |

**Total:**
**25 500 kg**

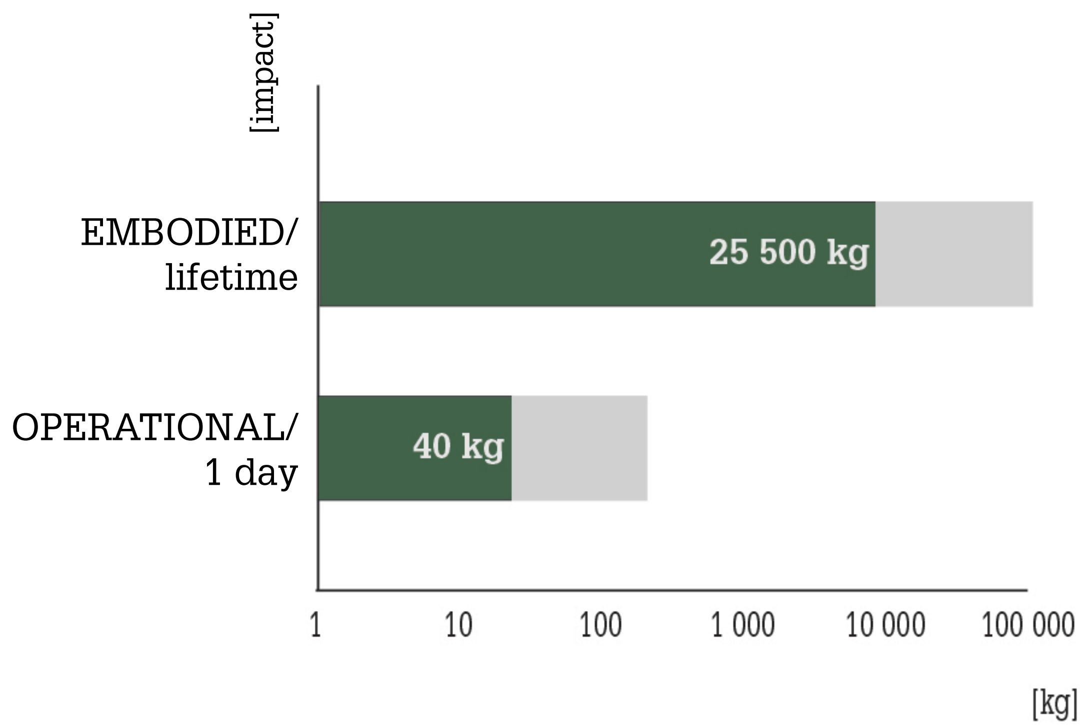
[Source: Architizer.com]

# STEP 5 - Common coin

## Household EFFICIENCY

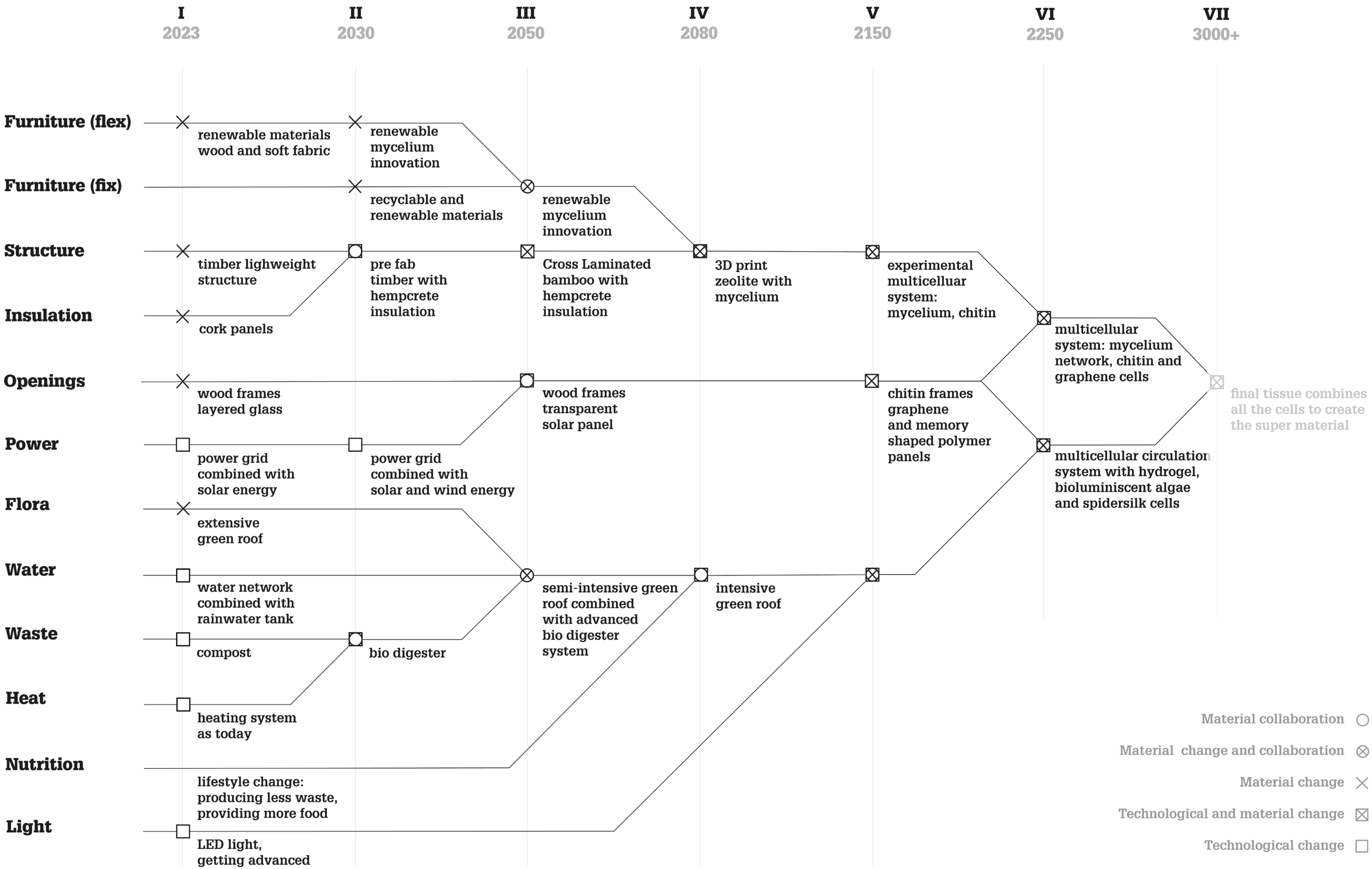



## Household IMPACT



# LET'S TAKE ANOTHER STEP FURTHER

# Evolution towards the Next House



# STEP 6 - 2250

1. Furniture (flex and fixed), Structure and Insulation

   - multicellular system which is a collaboration of mycelium network, chitin and graphene cells
   - **spidersilk innovation in furnitures and structure: combines wardrobe with walls**

5. Openings, Power, Flora, Water, Waste, Heat, Nutrition and Light

   - all windows and doors have chitin frames
   - multicellular system which is a collaboration of graphene, mycelium network, bioluminiscent algae and hydrogel
   - flexible such as the structure
   - bioluminiscent algae floor provides light

**The whole house is a mycorrhizal network.**


### STEP 6

***MATERIAL efficiency:*** *New implementation of multicellular tissue (multicellular tissue 300 years – 100% efficiency) and circulation system (algae with hydrogels 100 years – 80% efficiency).*

MATERIAL efficiency = 80-90%

SPACE efficiency = 16.2 ÷ 22
= 74%

Operational CO2 impact/day
= water + electricity + gas + waste + food + CO2 + O2
= 0 + 0 + 0 + 0 + 0 + *same* + *same*
= 0kg

Embodied CO2 impact/lifetime = 9 999kg

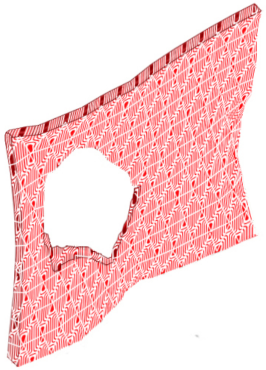
## STEP 6

SCALE 1:5

0 0.1 0.2 0.3 0.4 0.5 1m

# STEP 6 - Material efficiency

- Multi-cellular wall/Multi-celluler tissue

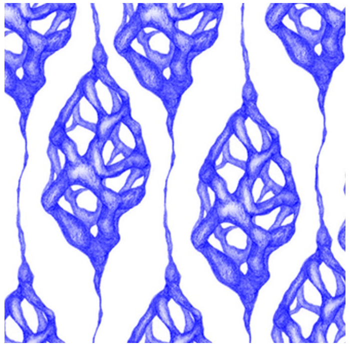


300 years
Usespan of element

300 years
Lifespan of material

**100%**
**Material Efficiency**

- Circulation system/Algae + Hydrogels



80 years
Usespan of element

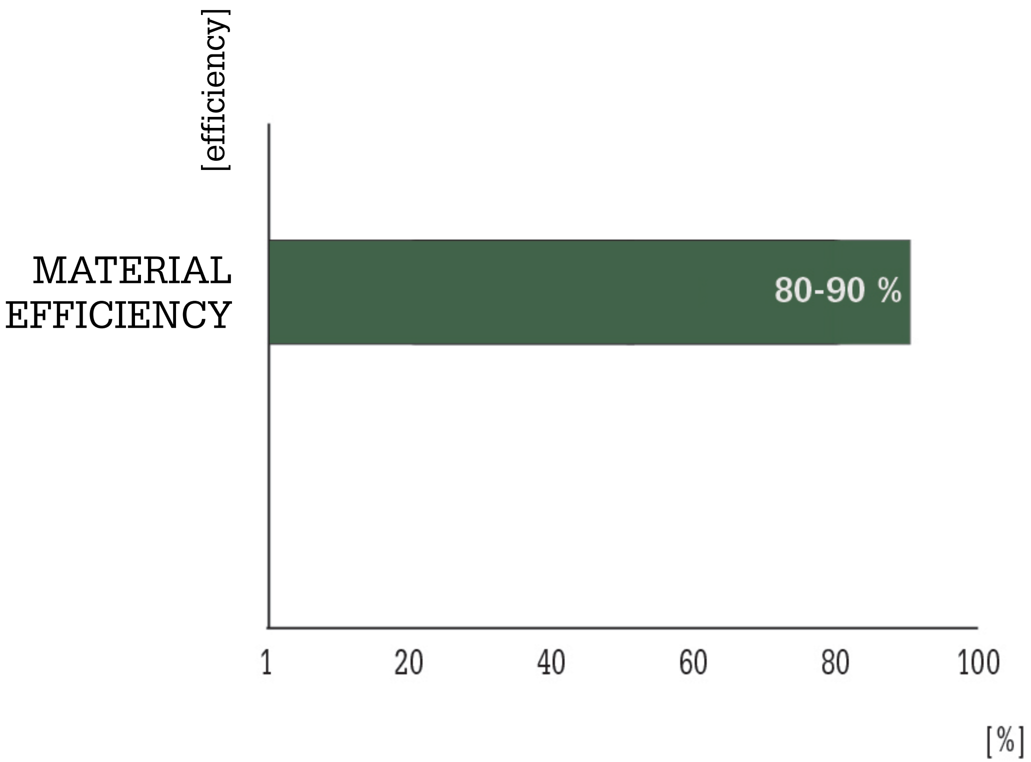
100 years
Lifespan of material

**80%**
**Material Efficiency**

[Source: Sciencedirect.com]

# STEP 6 - Common coin

## Household EFFICIENCY



## STEP 6 - Space efficiency

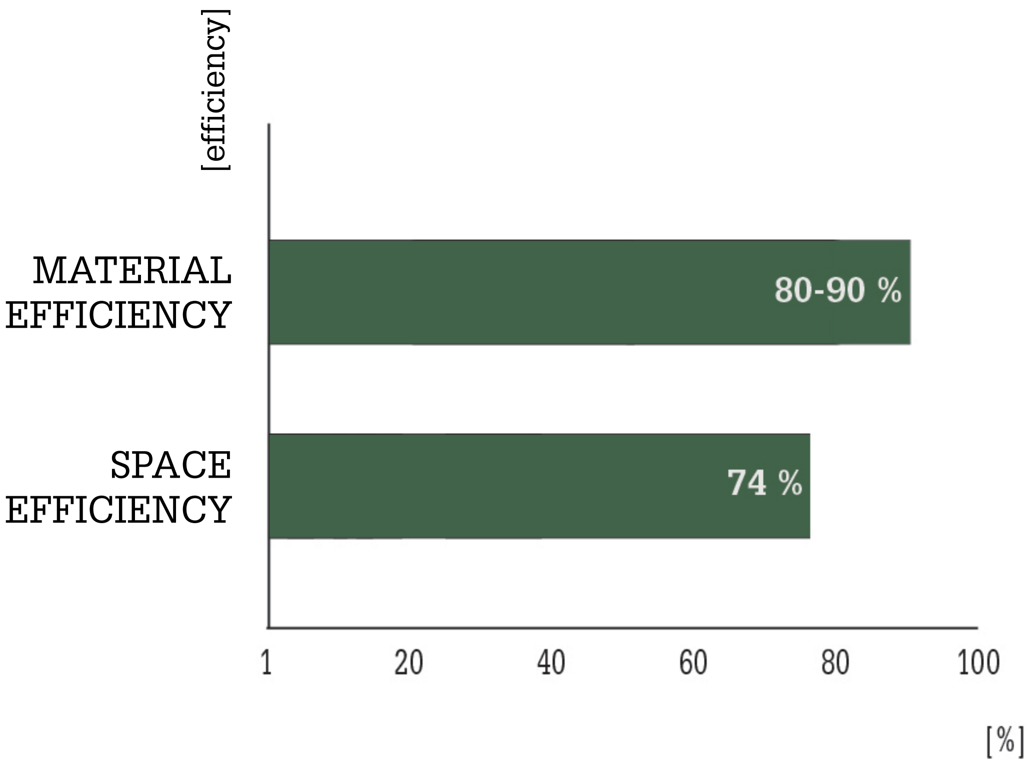
$$\frac{16.2\ m^3 \text{ Space we need}}{22\ m^3 \text{ Space we use}} = 74\%$$

**74%**

**Household space efficiency**

# STEP 6 - Common coin

## Household EFFICIENCY



# STEP 6 - Impact

## Operational $CO_2$ equivalent per day

| | | |
|---|---|---|
| Water | **0 kg** | ~~10 kg~~ |
| Electricity | **0 kg** | ~~1 kg~~ |
| Gas | **0 kg** | ~~5.4 kg~~ |
| | ... | |

**Total:**
**0 kg**

## Embodied $CO_2$ equivalent per lifetime

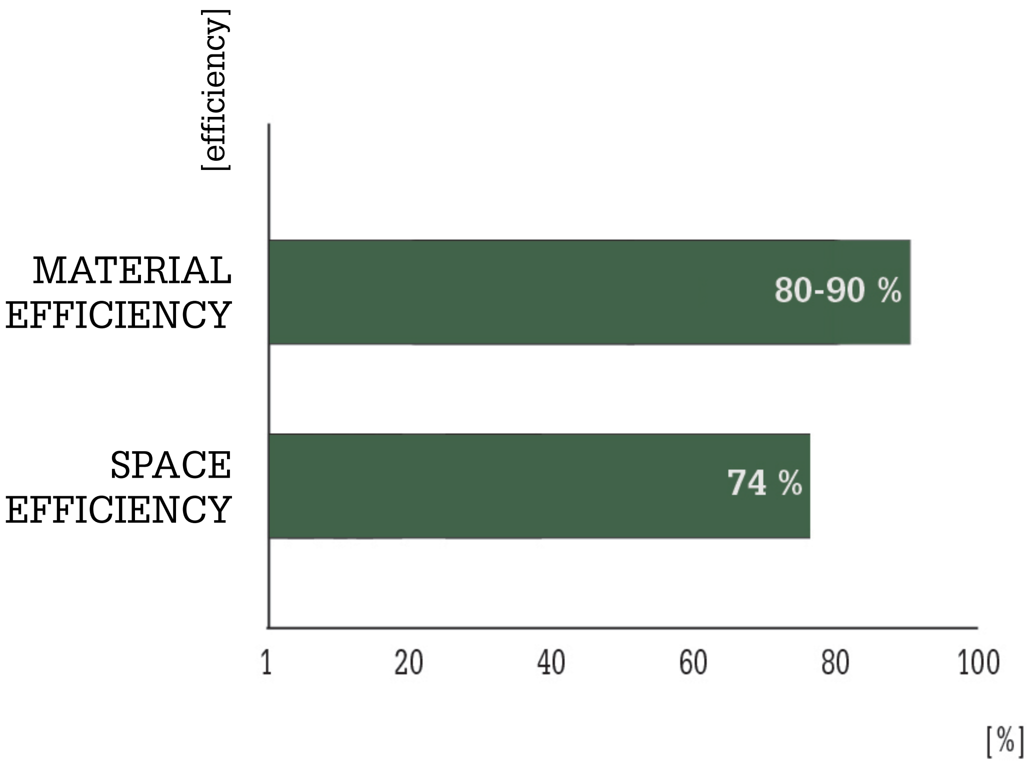
| | | |
|---|---|---|
| Mycelium | **3 kg** | ~~9 kg~~ |
| ~~Polymers~~ Hydrogels | **18 kg** | |
| ~~Chityn~~ Algae | **8kg** | |
| | ... | |

**Total:**
**9 999 kg**

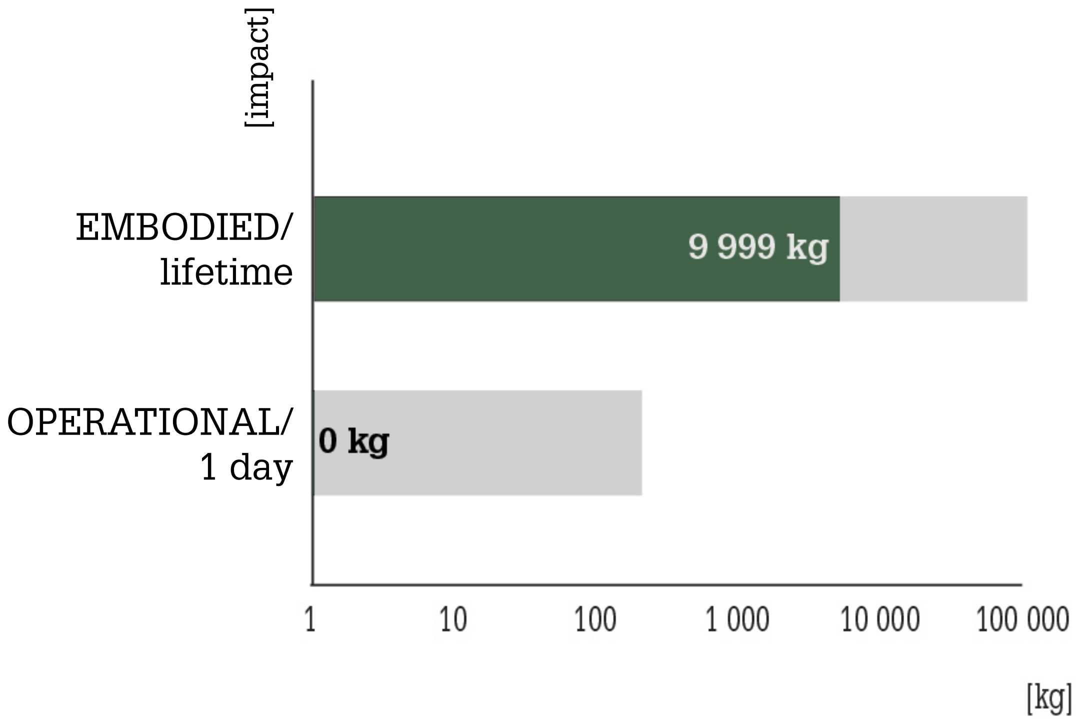
[Source: Sciencedirect.com]

# STEP 6 - Common coin

## Household EFFICIENCY



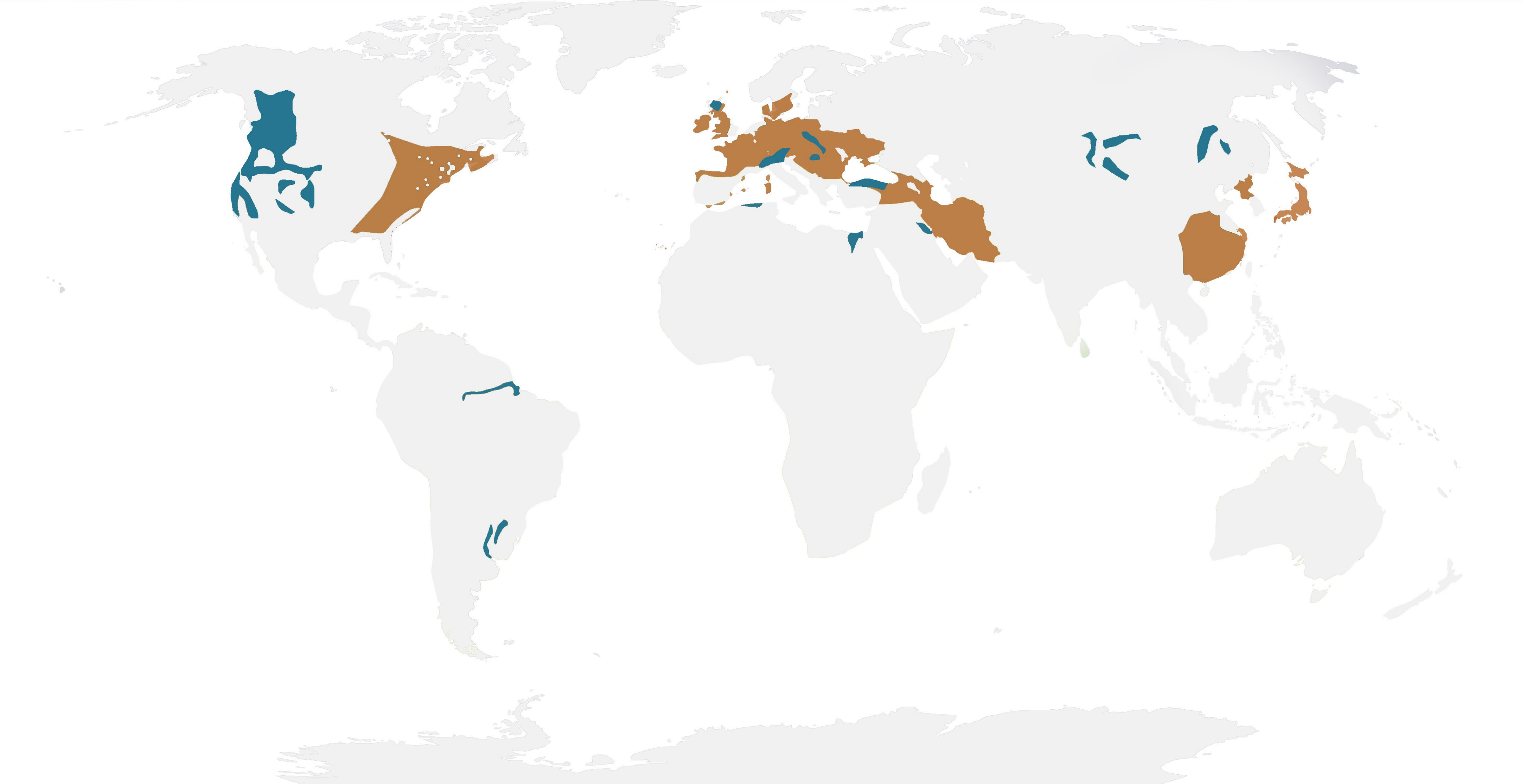

## Household IMPACT



# BUT DOES THIS NEXT HOUSE WORK JUST AS WELL ALL AROUND THE PLANET?

# WHAT CHANGES IN DIFFERENT BIOMES?

# The temperate biomes



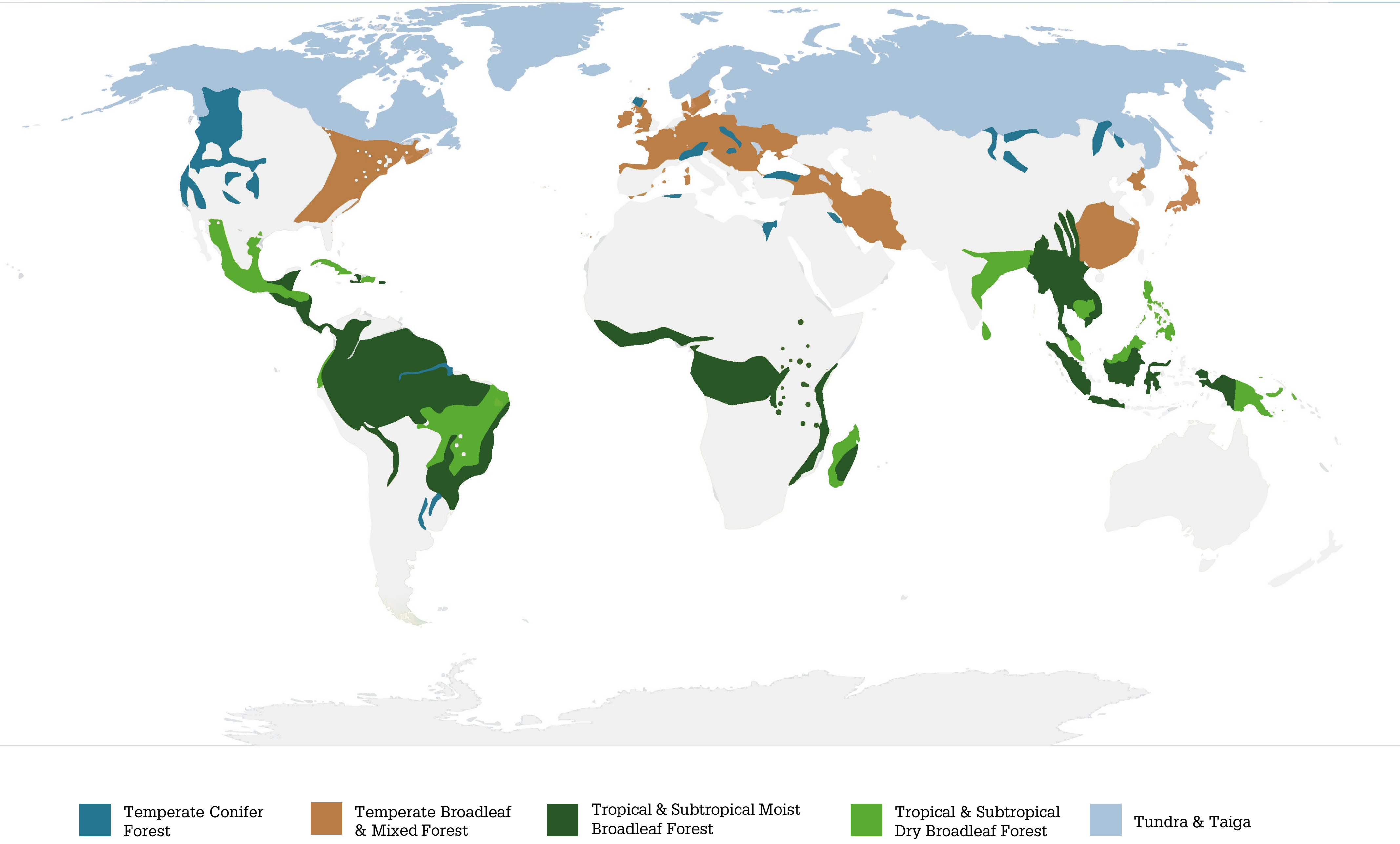
Temperate Broadleaf & Mixed Forest

Temperate Conifer Forest

[Source: Biotopia]

# WHAT BIOMES SHOULD WE CHOOSE ?

# The selected biomes

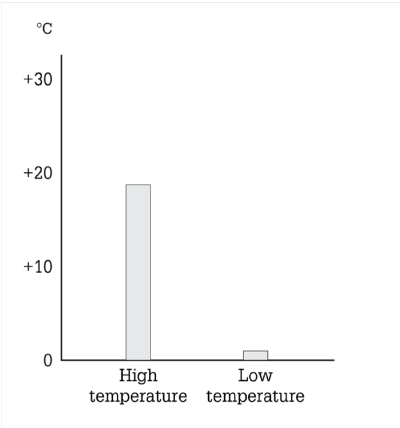



[Source: Biotopia]

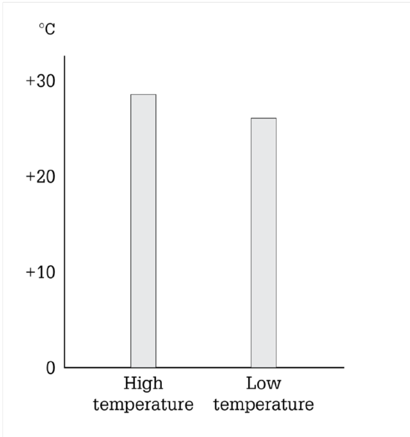
# Selected biomes – Average weather conditions

Comparison of temperature

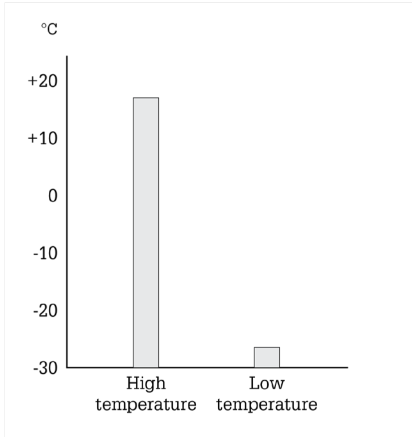
Temperate biomes




Tropical & Subtropical biomes




Taiga & Tundra biomes

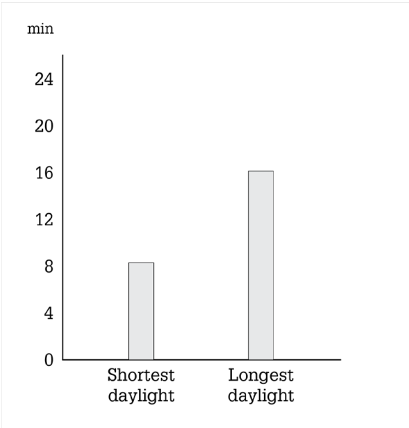



[Source: Climate-data.org]

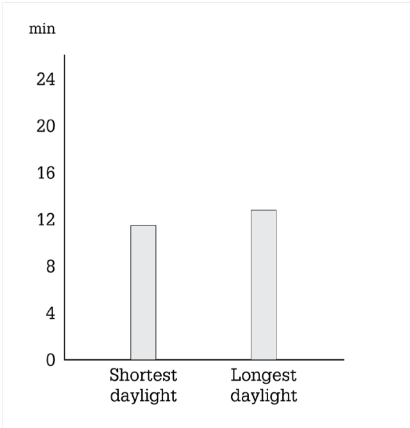
# Selected biomes – Average weather conditions

Amount of daylight during the year

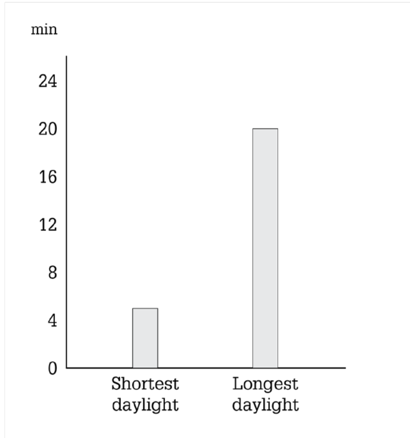
Temperate biomes




Tropical & Subtropical biomes




Taiga & Tundra biomes

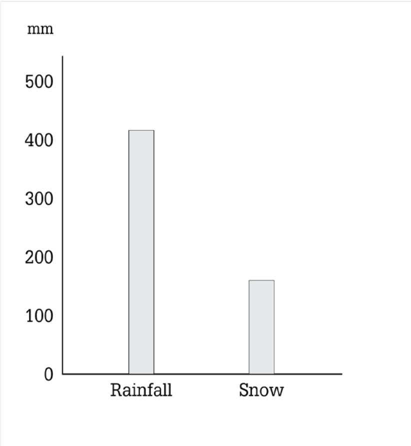



[Source: Climate-data.org]

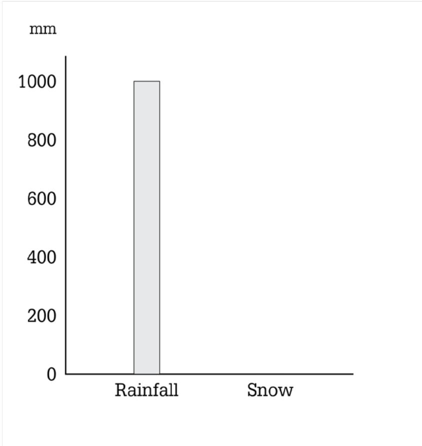
# Selected biomes – Average weather conditions

Amount of average rain and snowfall

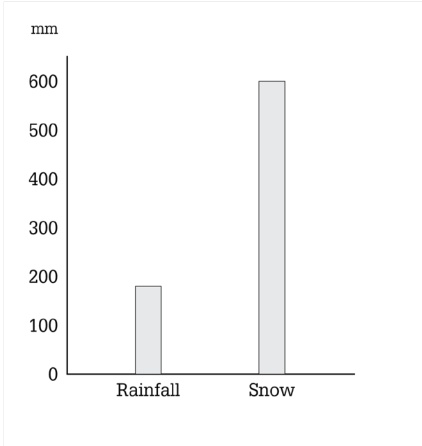
Temperate biomes




Tropical & Subtropical biomes




Taiga & Tundra biomes



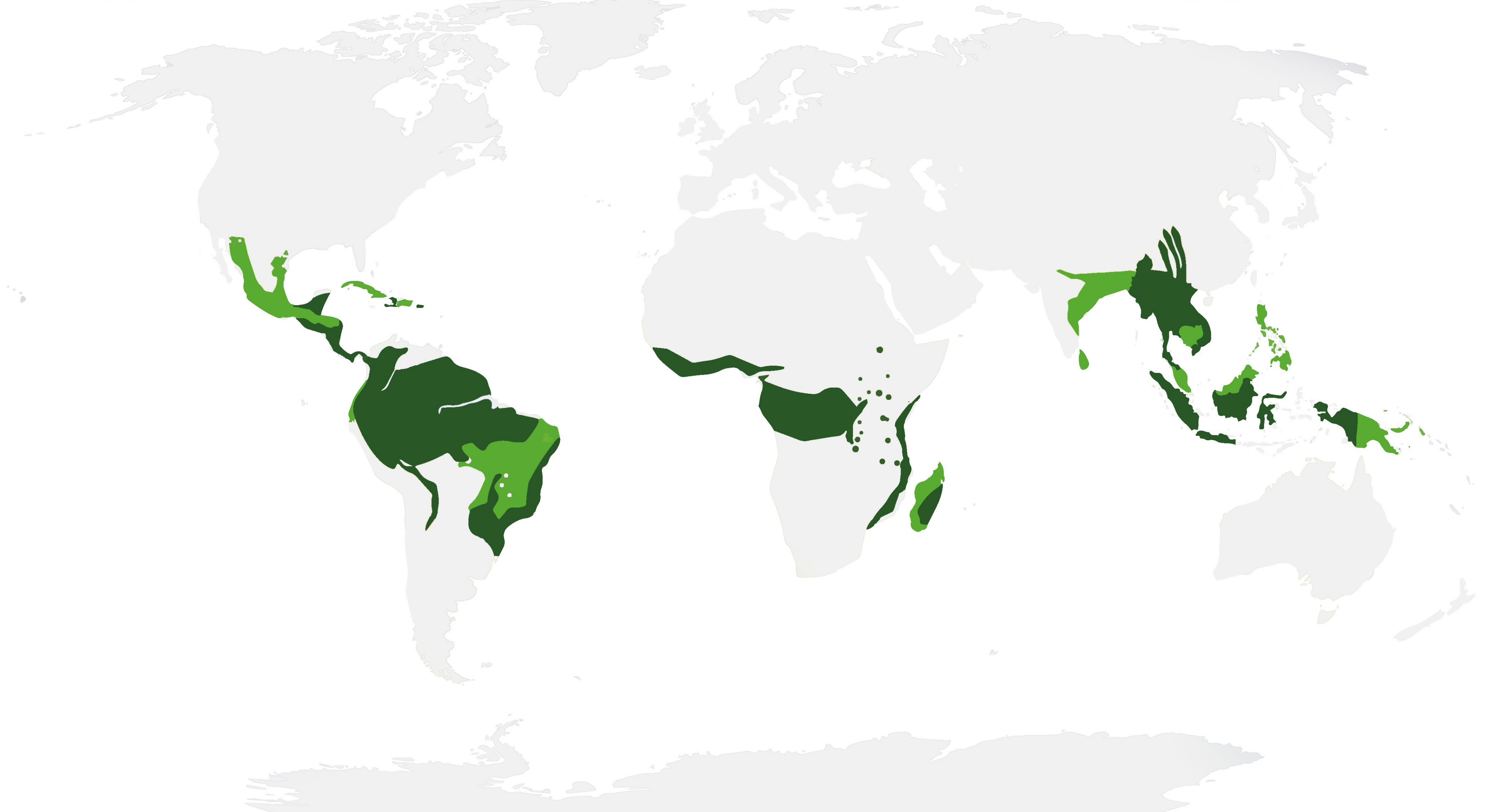

[Source: Climate-data.org]

# 6.2
# NEXT HOUSE IN OTHER BIOMES

**Adapting the Temperate Biome's Next House to other choosen biomes, by changing some materials and technologies to suit different climatic conditions.**

# TROPICAL & SUBTROPICAL BIOMES

# The tropical and subtropical biomes

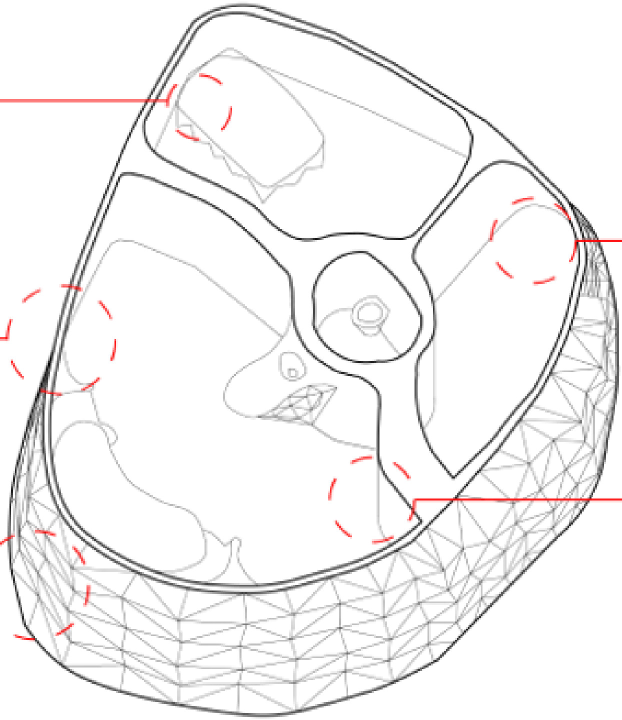


Tropical & Subtropical Moist Broadleaf Forest

Tropical & Subtropical Dry Broadleaf Forest

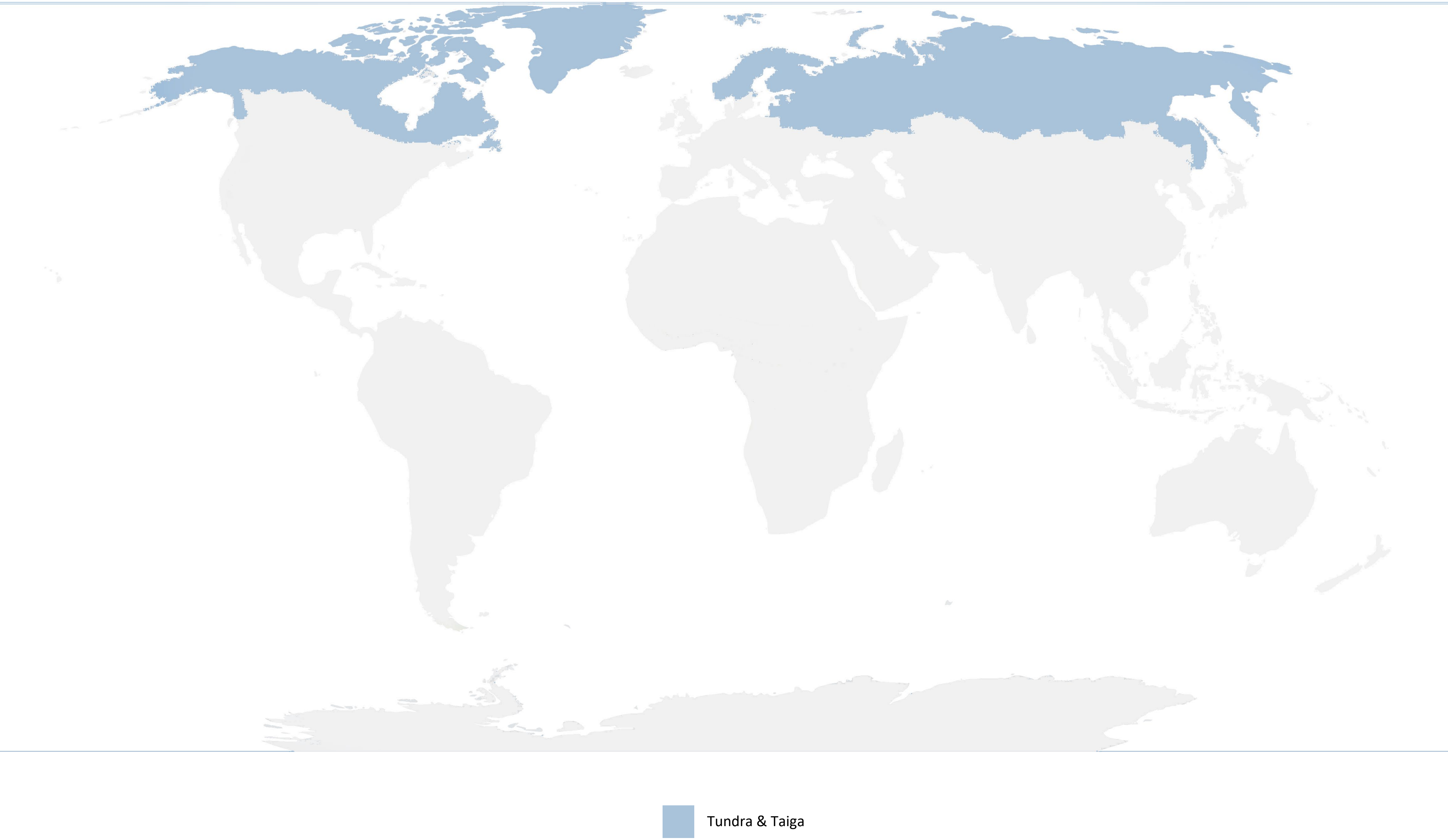
[Source: Biotopia]

# Tropical biome – Changes to the Next House



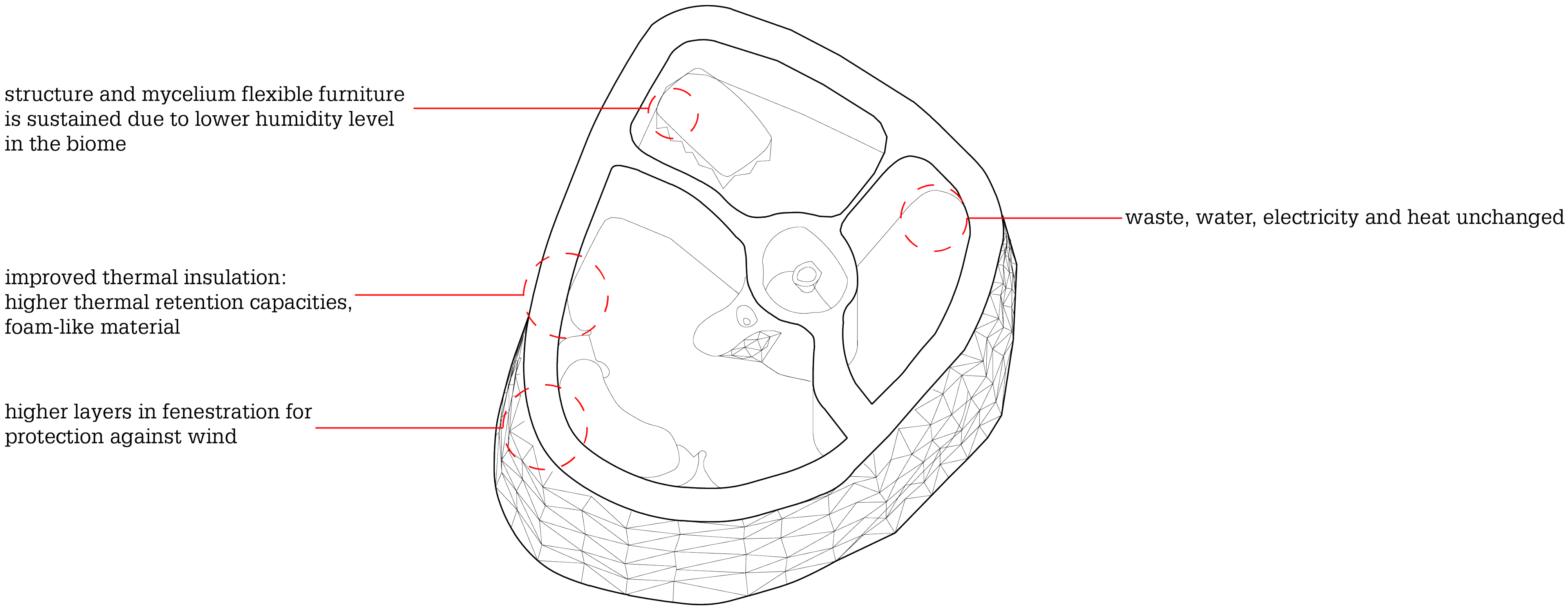
# TAIGA & TUNDRA BIOMES

# The temperate biomes




[Source: Biotopia]

# Taiga biome – Changes to the Next House



**In this chapter, many stages of the Next House have been developed over time in order to reduce our CO2 impact, and it has even been adapted to other biomes.**

# CAN WE CREATE A FAR FUTURE HOUSE THAT ADAPTS ITSELF TO ANY BIOME?

# WHILE HAVING EVEN LESS IMPACT?

# 7

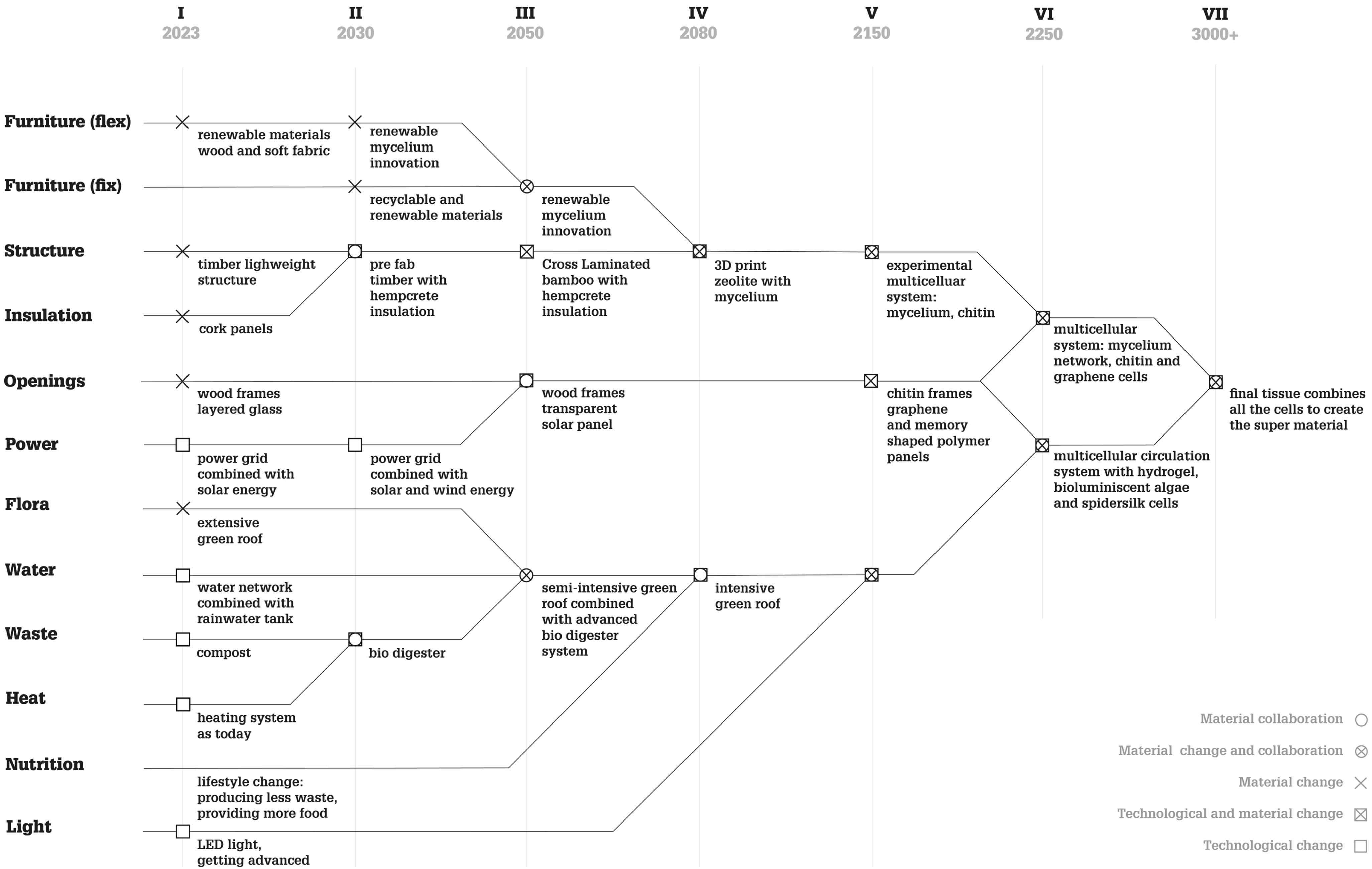
# FAR FUTURE HOUSE:

## THE ULTIMATE BIOLIVING

## What should the BioHouse?

# Adjustable?
# self-repairable?
# biofriendly?
# biodegredable?
# emission-free?

# Evolution towards the Far Future House



# IF ONE HAS TO DO IT ALL, ITS ALMOST LIKE A SECOND SKIN

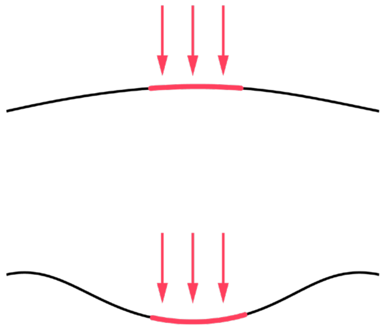
# A SKIN WITH ALL THE PROPERTIES INTEGRATED INTO ITS STRUCTURE

# BUT HOW?!

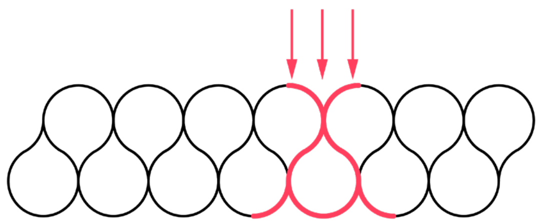
# Structure

In order to be structural, material needs to be dense and strong enough to bear large loads without any deformations.

Wood gets its strength from its longitudinal cellulose fibers and high density.



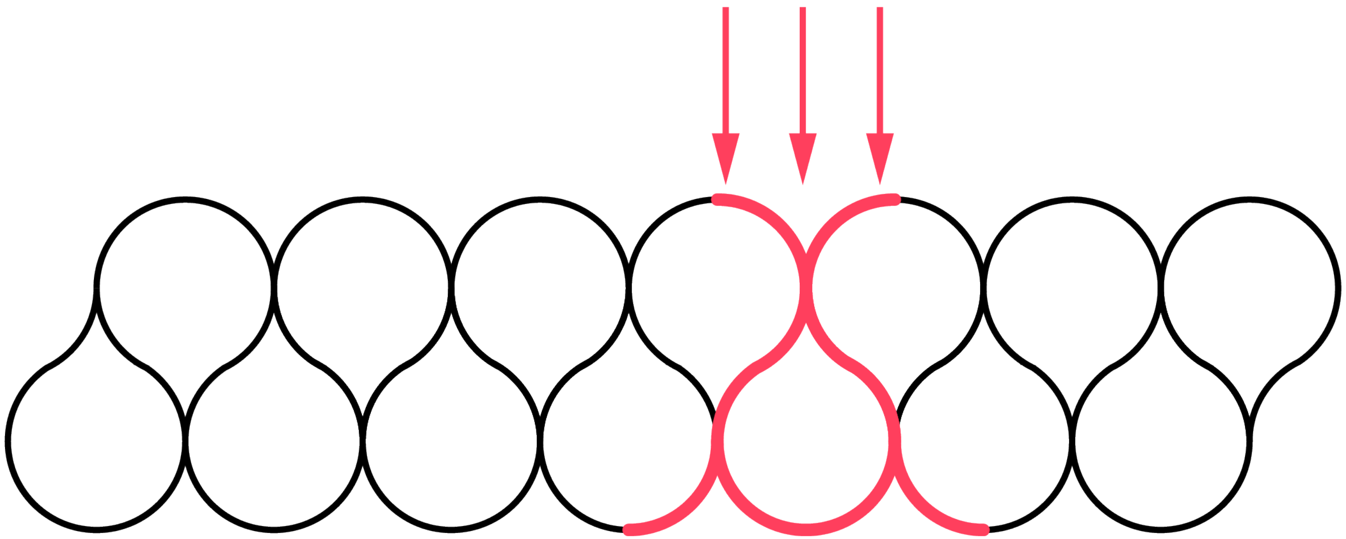
Densifying our supermaterial creates longitudinal load-bearing structure.



wood

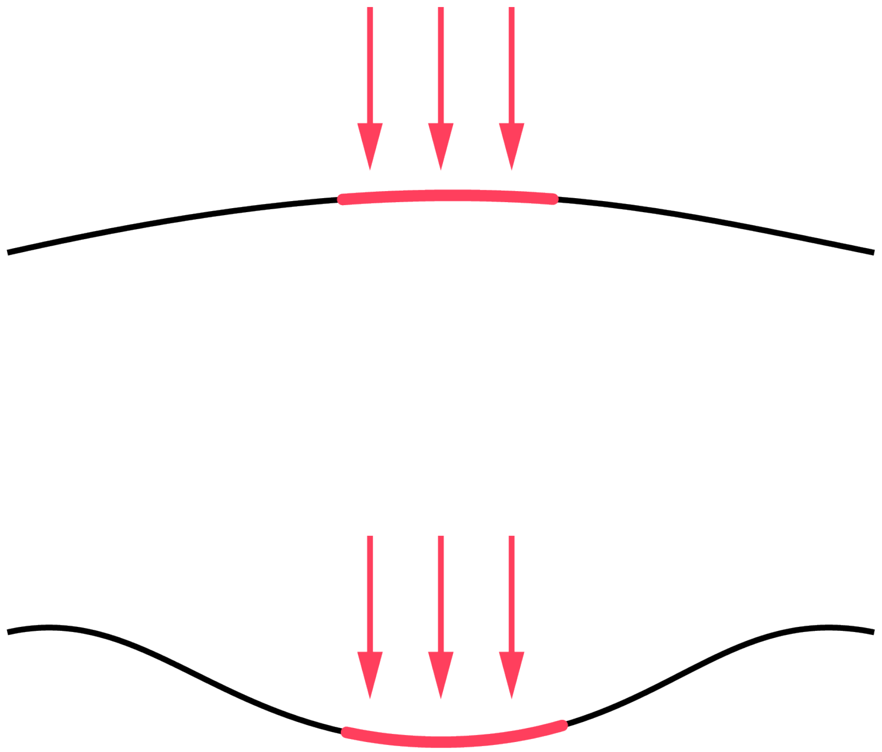
## Supermaterial needs to be flexible

## Structure



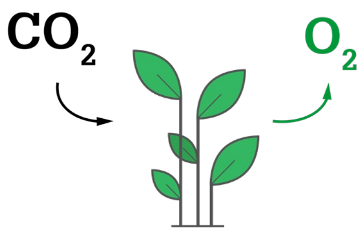
**Skin should be able to provide structure by folding**

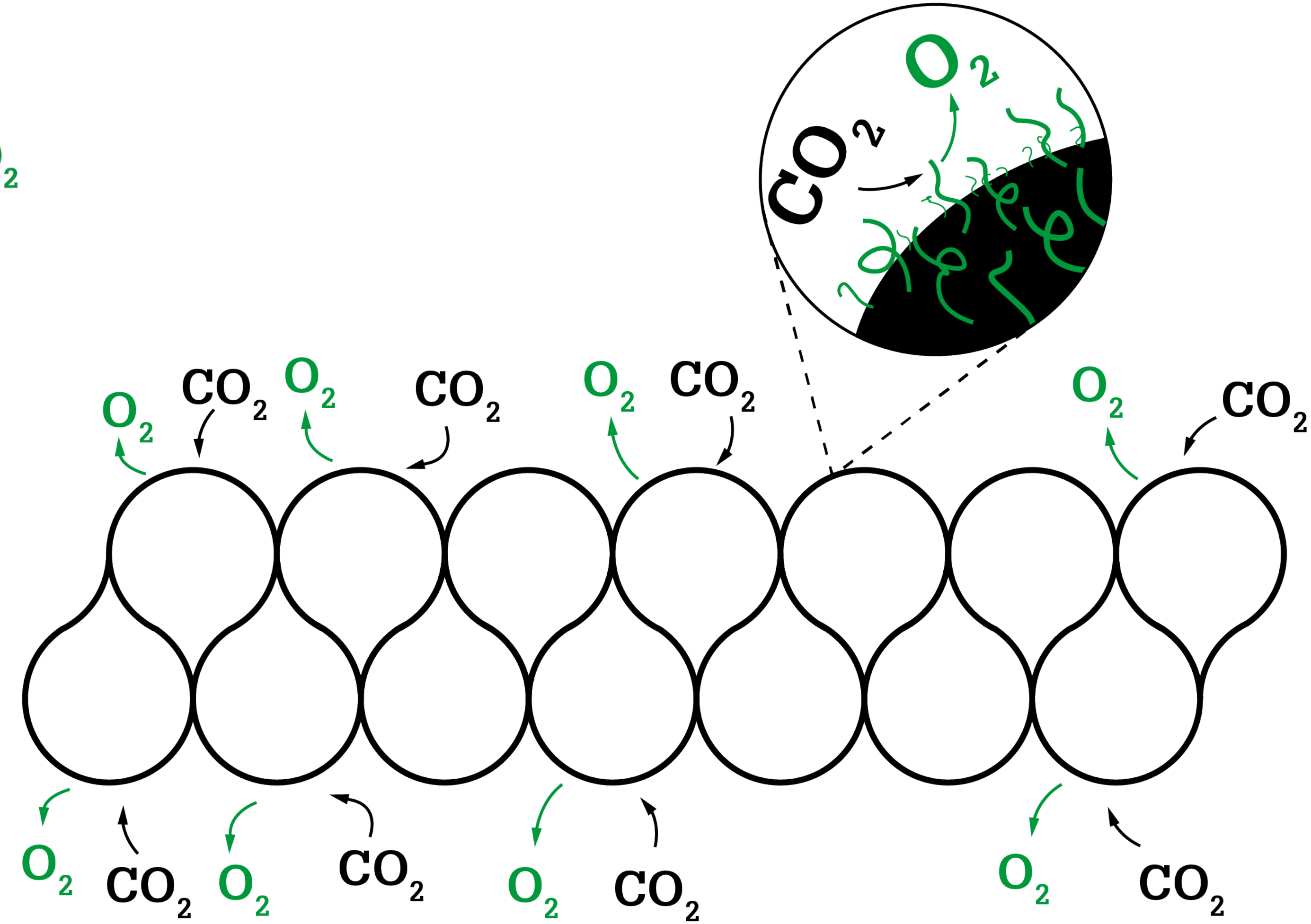
# Flexibility



**Skin should be flexible**

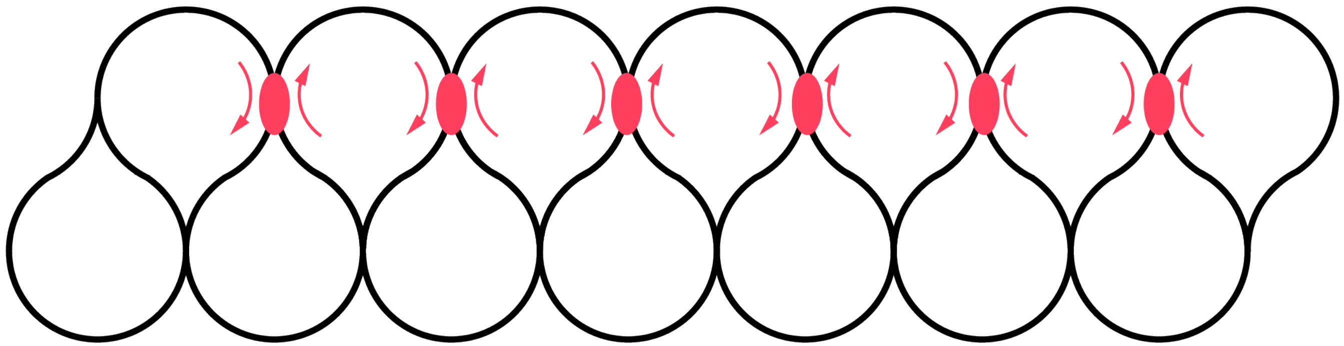
# Oxygen



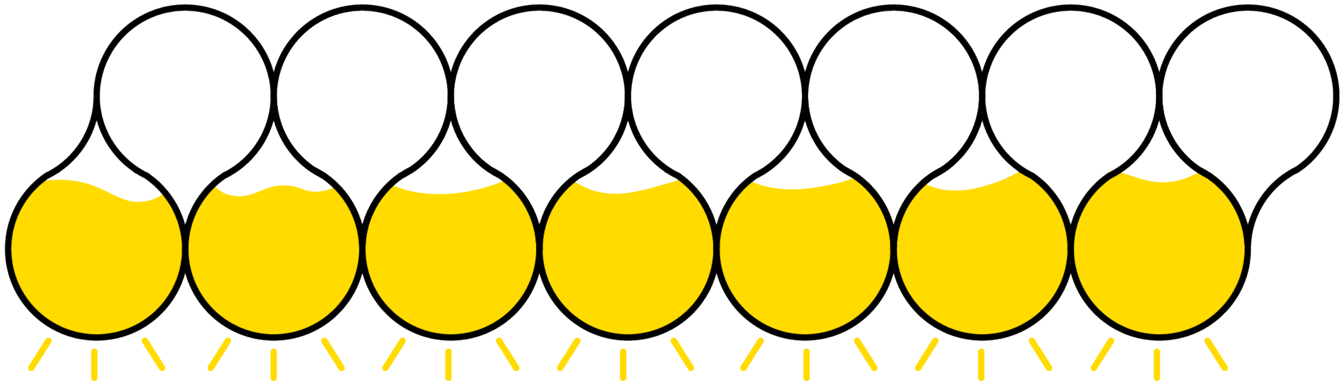

**Skin should allow for photosynthesis to provide oxygen**

## Energy



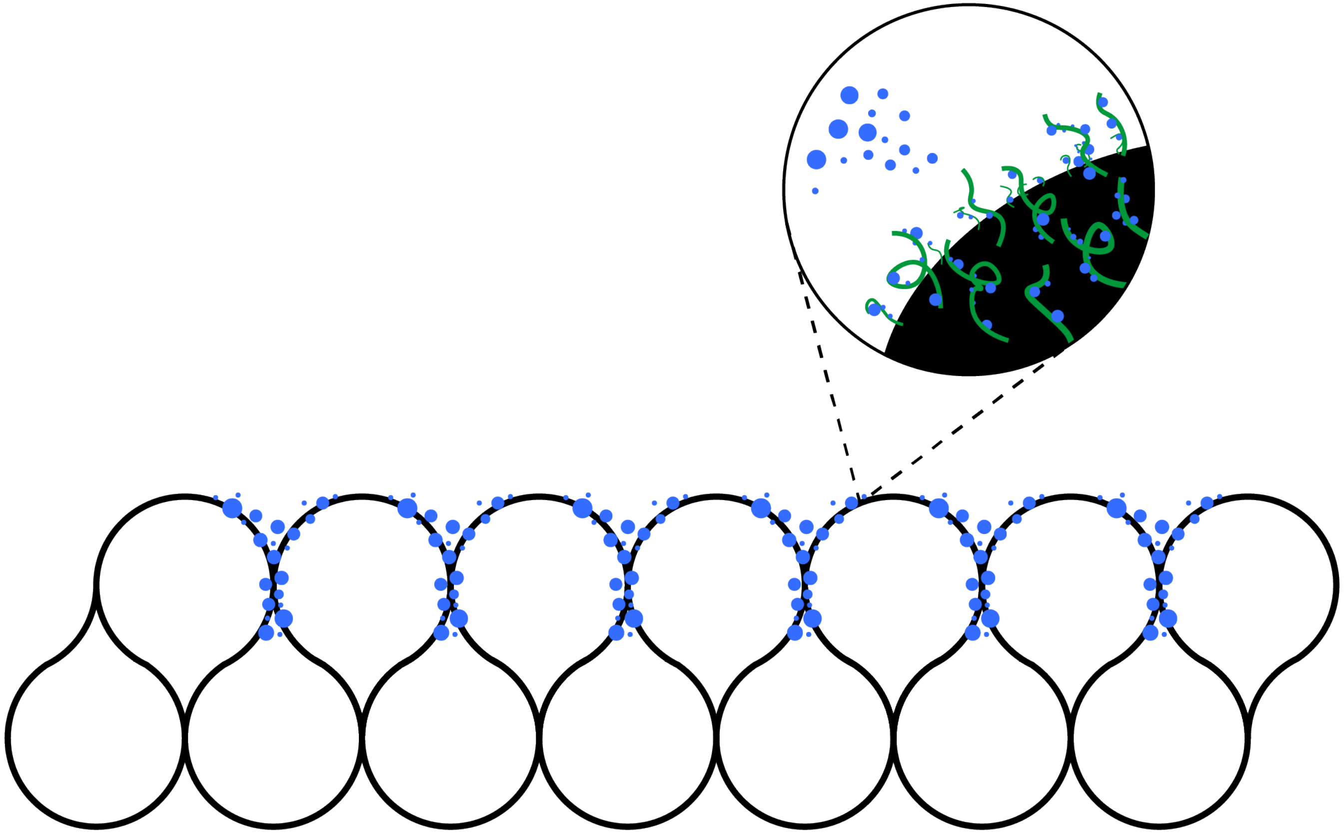
**Skin should be able to produce energy through friction**

## Light



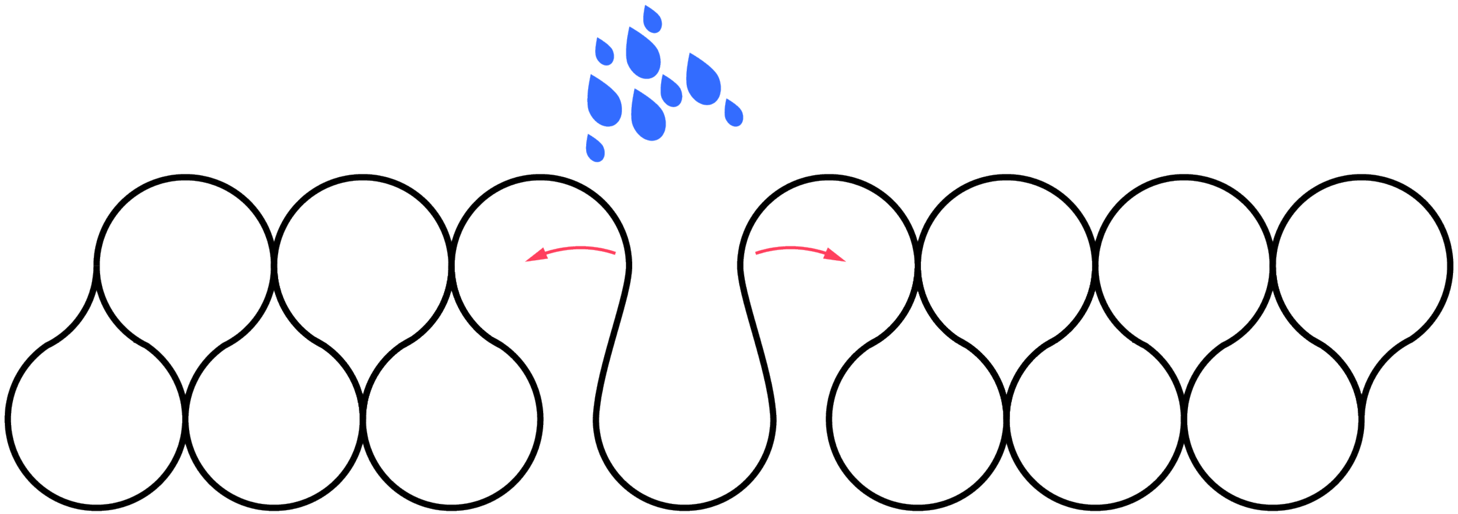
**And emit it as light when needed**

## Water



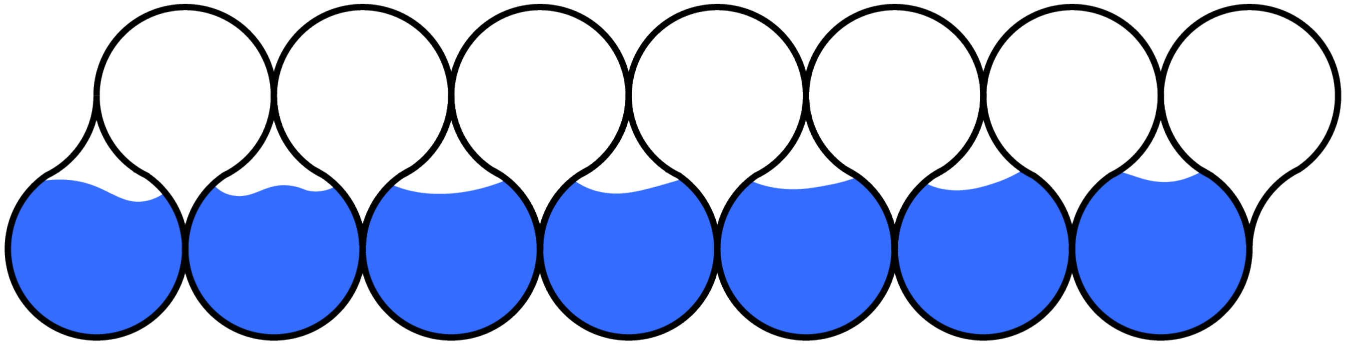
**Skin should capture humidity**

## Water



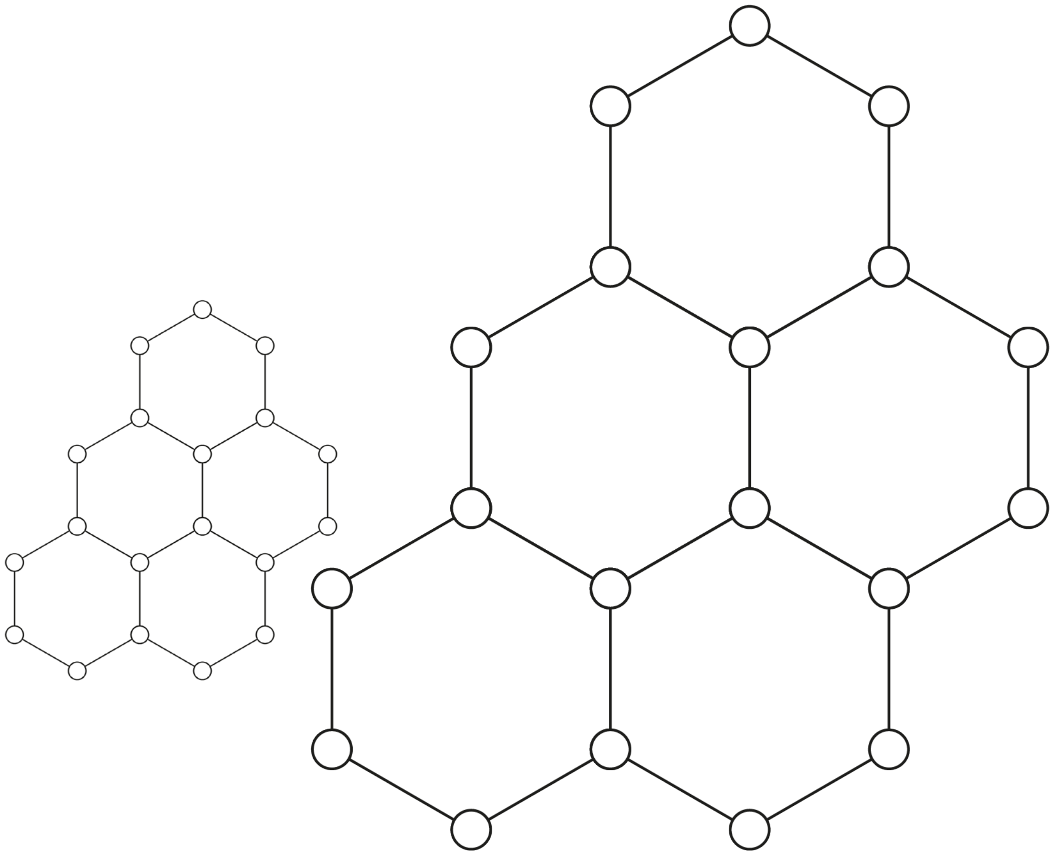
**It should also open up...**

## Water



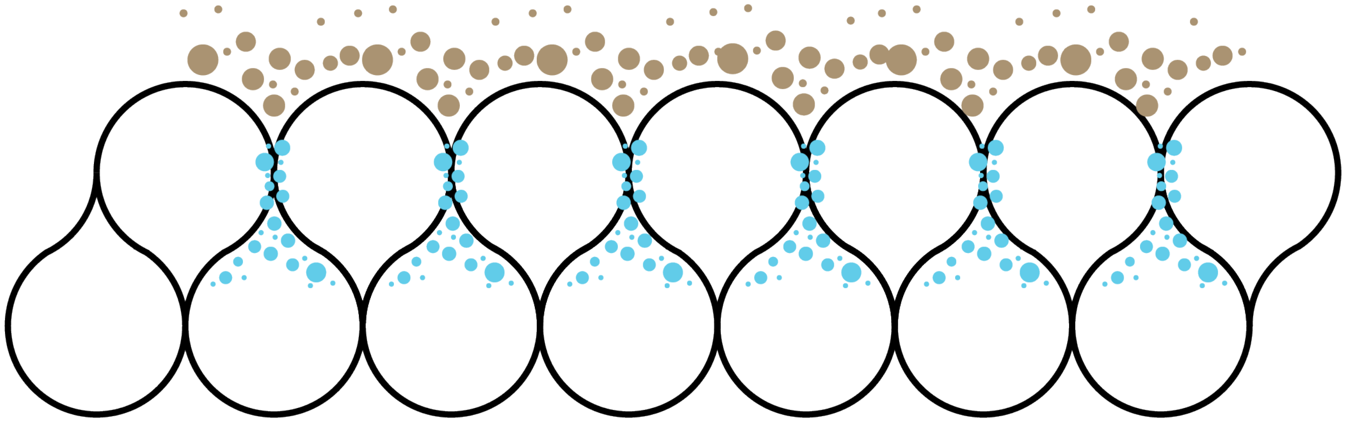
**To store the water for daily use.**

# Transparency



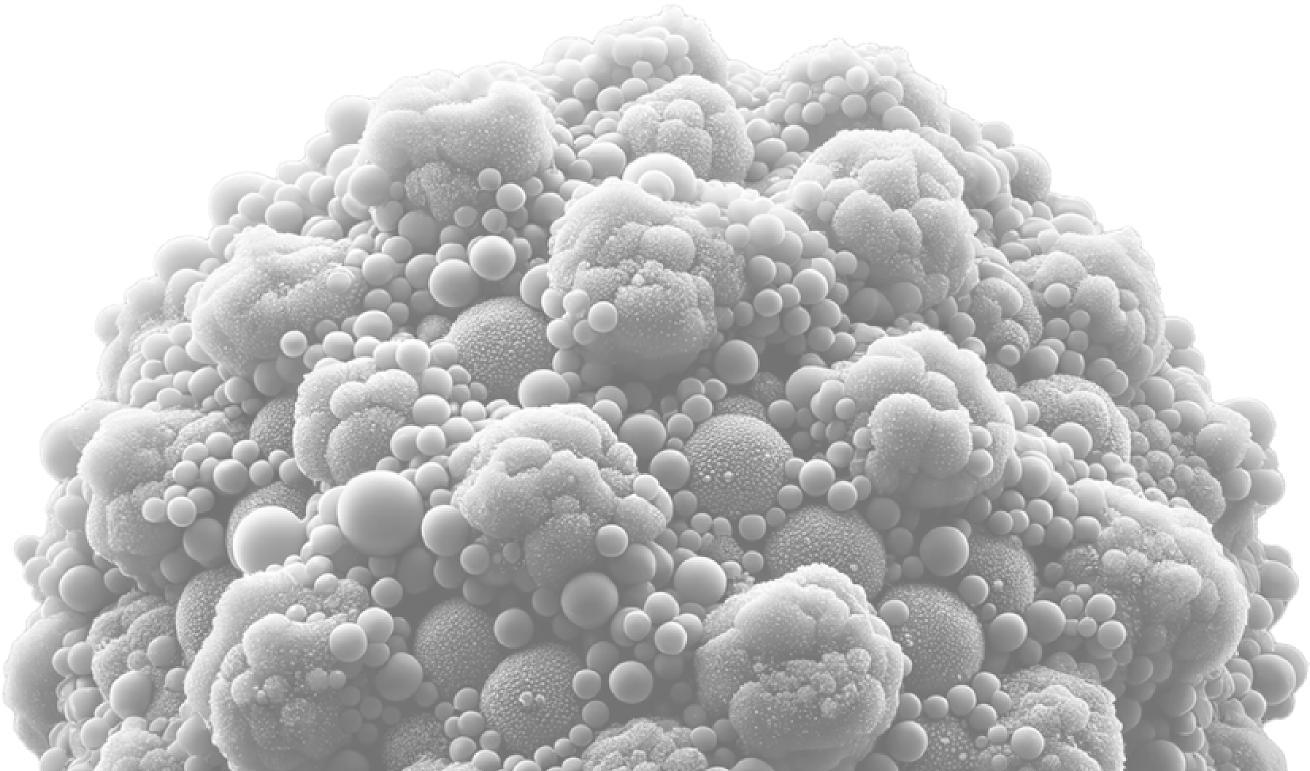
**Skin should also become transparent by changing molecular density**

# Waste



**Skin should filter & clean waste**

# THE SPONGE



# SPONGE

Skin-like material that provides everything we need and wish for. Environmentally-friendly alternative in contemporary building industry. Sponge is also suitable for changing conditions and is ideal for various applications. This material represents the future of sustainable and multifunctional solutions across various industry sectors.

**Lifespan :**
**Footprint :**

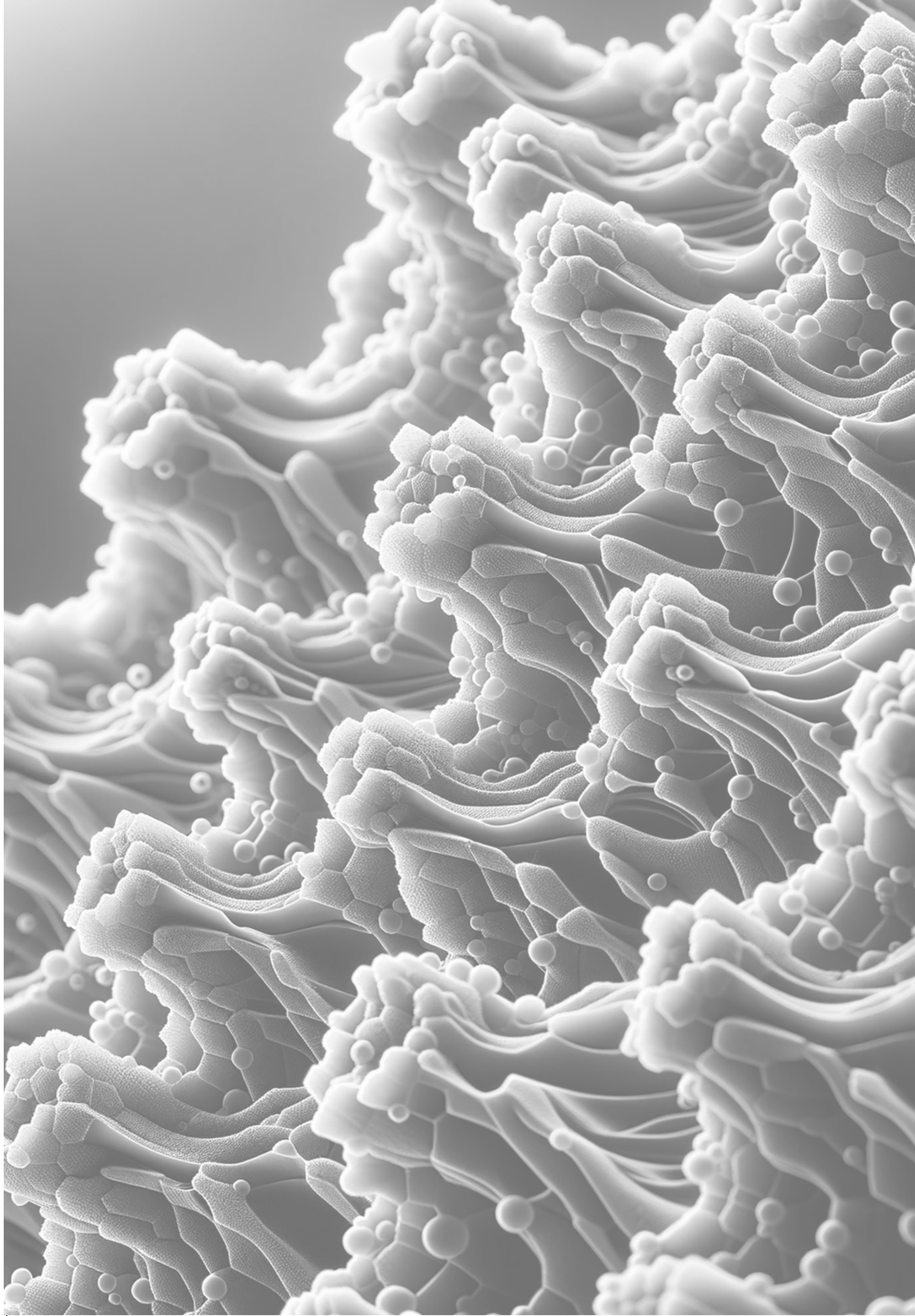
## Properties:

- Oxygen
- Furniture
- Structure
- Heat
- Nutrition
- Water
- Transparency
- Ventilation
- Electricity
- Light
- Smell insulation
- Sound insulation

- Thermal insulation
- Waste
- Fire-resistant
- Corrosion-resistant
- Elastic
- Recyclability
- Biodegredability
- Adaptability
- Fauna hosting
- Flora hosting
- Self-healing
- Durability

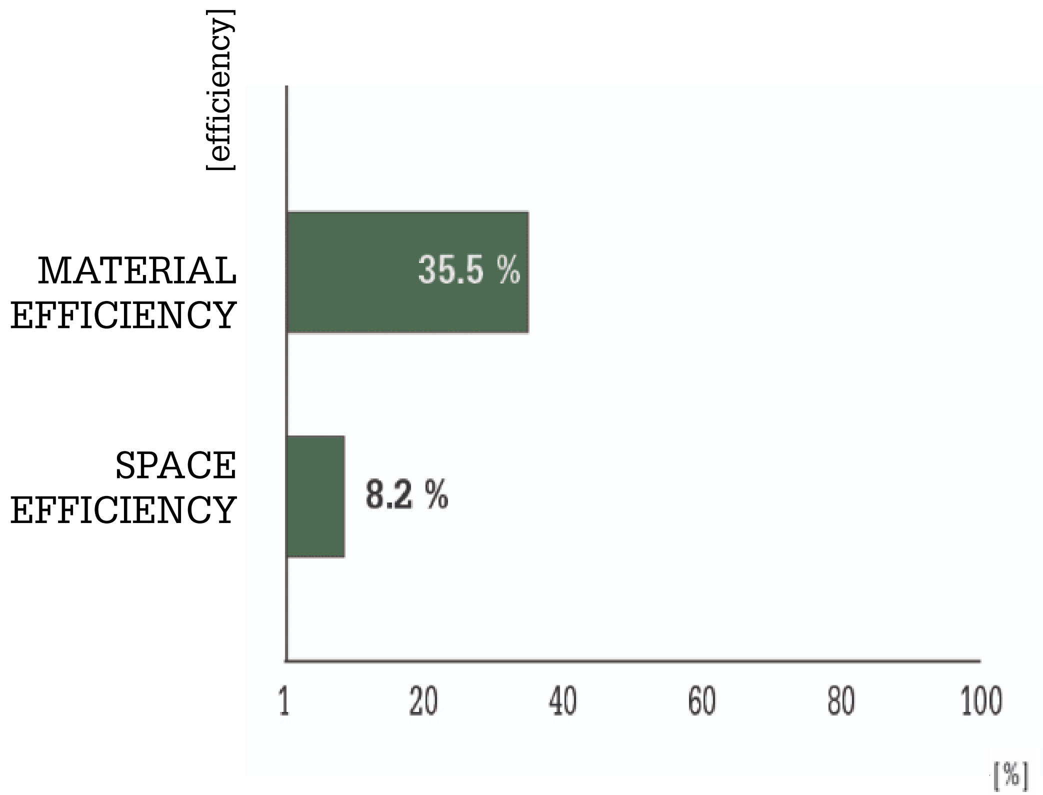
## Limitations:

- Heat sensitive
- Cold sensitive
- Humidity
- Light sensitive
- Water dependent
- Water soluble
- Fragile
- Toxic

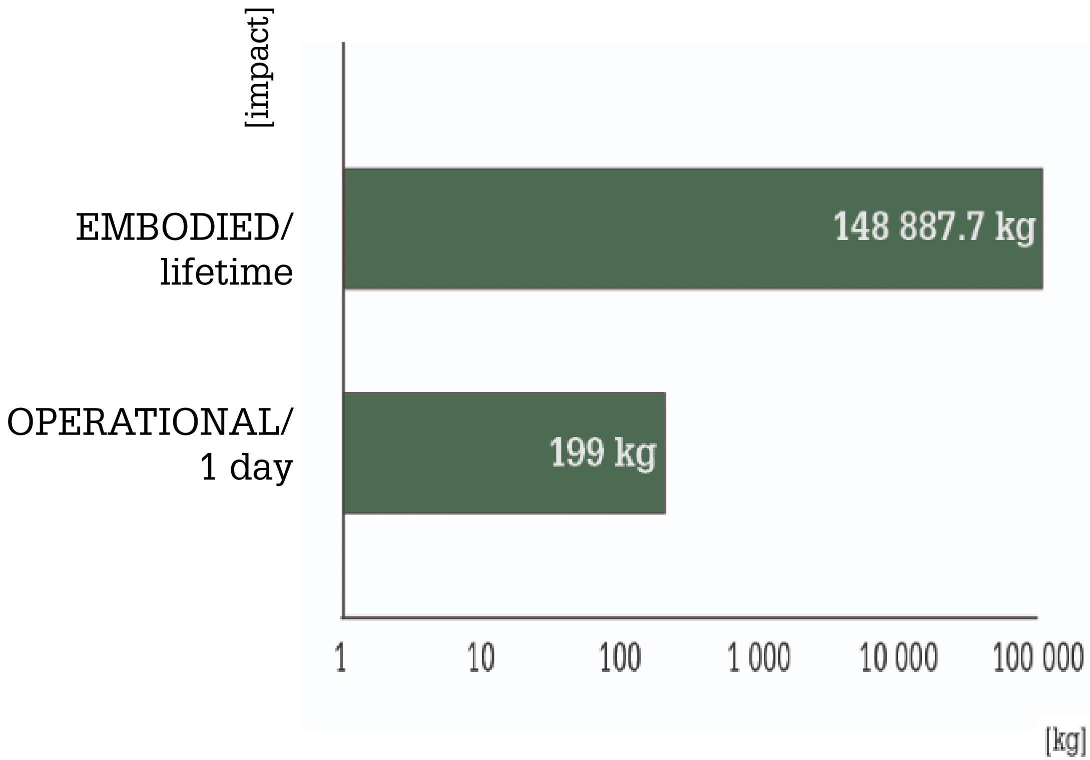


# STEP 7 - Common Coin

## Household EFFICIENCY




## Household IMPACT



# STEP 7 – 3000+


1. Final tissue combines all the cells to create
the super material:
- flexible skin structure, turns into transparent if needed
- provides oxgen, capture humidity and stores water
- emit light
- flexible for opening any space
- filters and cleans waste
STEP 7 - BIOHOUSE
MATERIAL efficiency = 100%
SPACE efficiency = 16.2 ÷ 16.2
= 100%
Operational CO2 impact/day
= water + electricity + gas + waste + food + CO2 + O2
= 0 + 0 + 0 + 0 + 0 + *same* + *same*
= 0kg
Embodied CO2 impact/lifetime = ?? kg
STEP 7
SCALE 1:5
0 0.1 0.2 0.3 0.4 0.5 1m
1.

# 8
# CONCLUSION

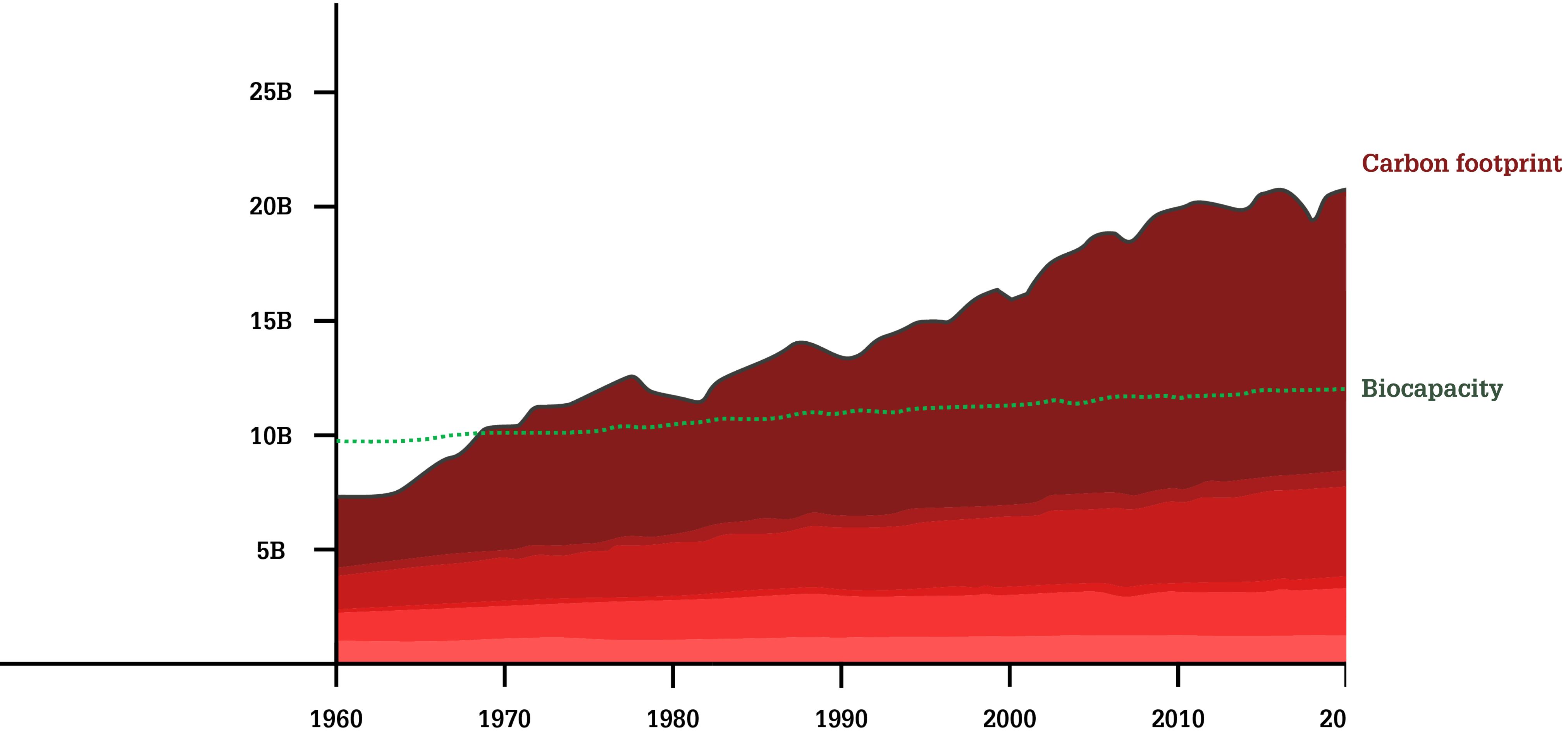
# WE HAVE SEEN THE WAY WE LIVE IS INEFFICIENT

# AND NON-BIOLOGICAL

# WITH HIGH IMPACT

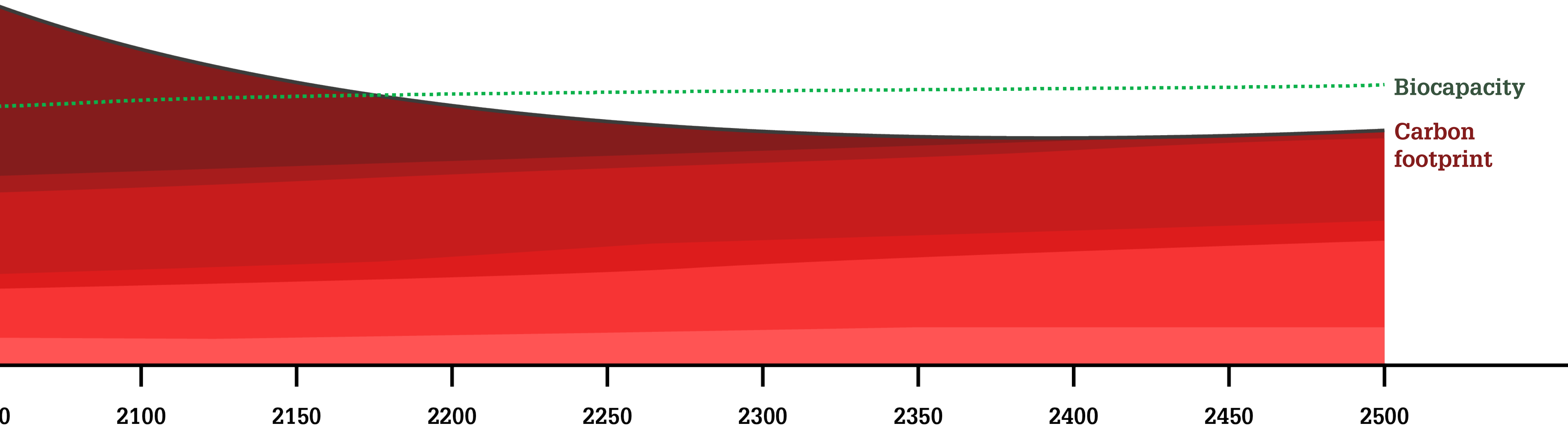
# WHICH OUTGREW OUR PLANET A LONG TIME AGO

# SO WE SET OUR GOAL TO ELIMINATE OUR BIGGEST ENEMY




[Source: Global Footprint Network]

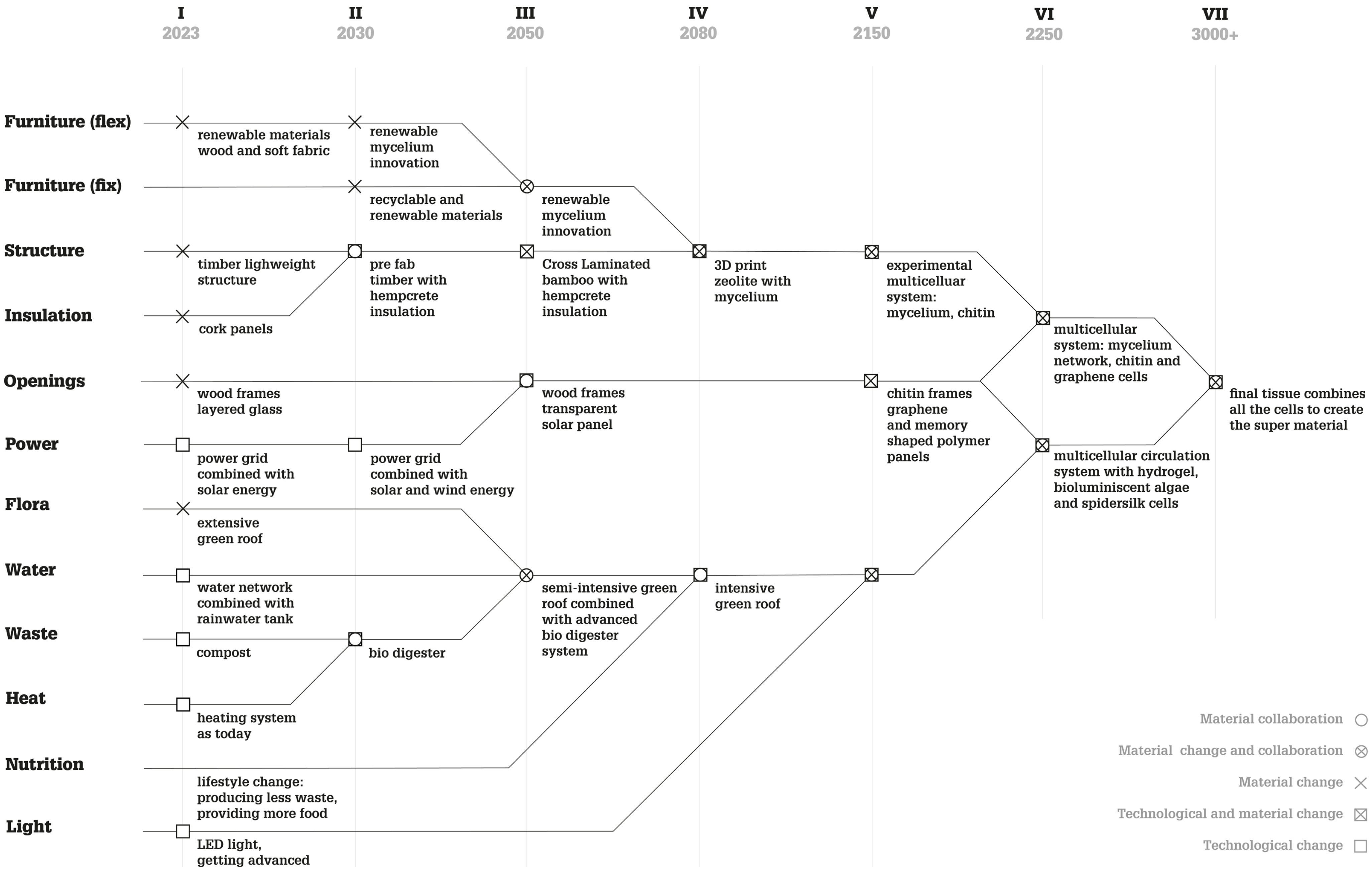
# AND RESTORE THE ORDER




[Source: Global Footprint Network]

# SO HOW DID WE DO THIS?

# Evolution towards the Far Future House



# WHAT CAN BE DONE NEXT?

# INTEGRATE RENEWABLE ENERGY?

# CONSIDER OUR NEIGBOURS?

# CONSIDER THE FLORA AND FAUNA?

# CONSIDER LIFESTYLE CHANGE?

YELYZAVETA BEREZINA / AINHOA DECORNET
ZOE FORLER / LOUISA GERGAUD
THEO GUSH / ESZTER HEGEDÜS
EMMA HORACKOVA / ANNA KUCEROVA
BARBORA LASSAKOVA / OLEG MAMYKIN
JILLIAN MAE LEE XIAN NING
ZLATA MASLIANA / ANASTASIIA MIKORA
ANASTAZIE MUCKOVA / NIKOL NAUMOV
MACIEJ OBERZIG / MIKULAS OTT
MARCEL PEREZ /ZI QING HOON
ZHAMILYA SATYBAYEVA / VERONIKA SCSEVLIKOVA
LANA TKHAPSHOKOVA
WINY MAAS
STAVROS GARGARETAS / JAKA KORLA
BARBORA STRNADOVA / MICHAL ZAPLETAL

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# 8 Conclusion

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