



# LIVING PLACES SCALABILITY

Typology and impact study

# Mission and main objective

## Main objectives: Development project

Is to reduce m2 price, Continuing to ensure a low LCA and to keep the healthy building principles. Target price is yet to be defined but initial price given from E+P should be lowered between 10-20% to ensure scalability.



**01**

### **REDUCE PRICE**

Target price:  
11.300 DKK ex. VAT / 14.500 DKK incl. VAT

**02**

### **KEEP OR REDUCE LCA**

Keep the LCA as low as possible.  
minimum <6kg CO<sub>2</sub>/ m<sup>2</sup>/year

**03**

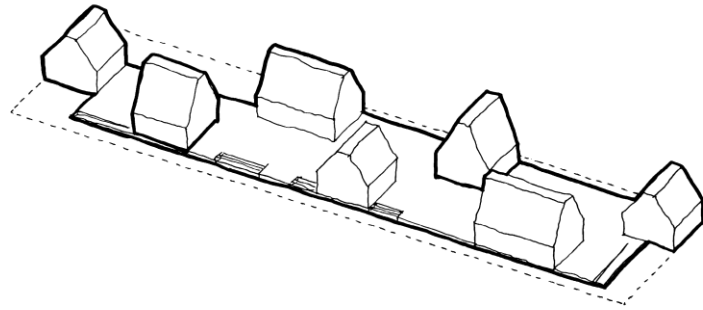
### **KEEP OR INCREASE HEALTH**

Maintain a healthy indoor climate  
minimum Indoor climate classe 1 or 2

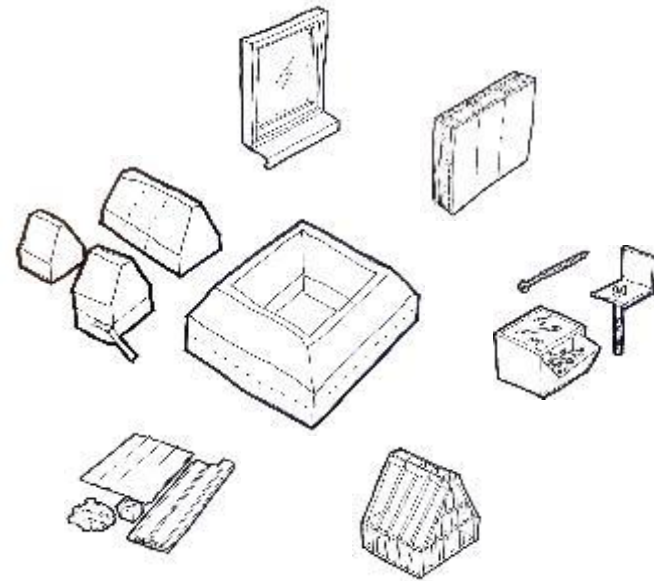
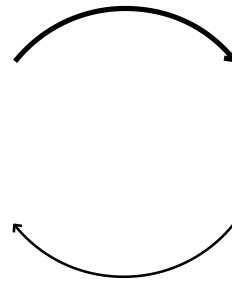
# Process and timeline

## Knowledge sharing: concurrently processes

To ensure that the process becomes as productive as possible, the development project should inform the Living Places Copenhagen about key findings and vice versa.



**Living places  
Copenhagen**

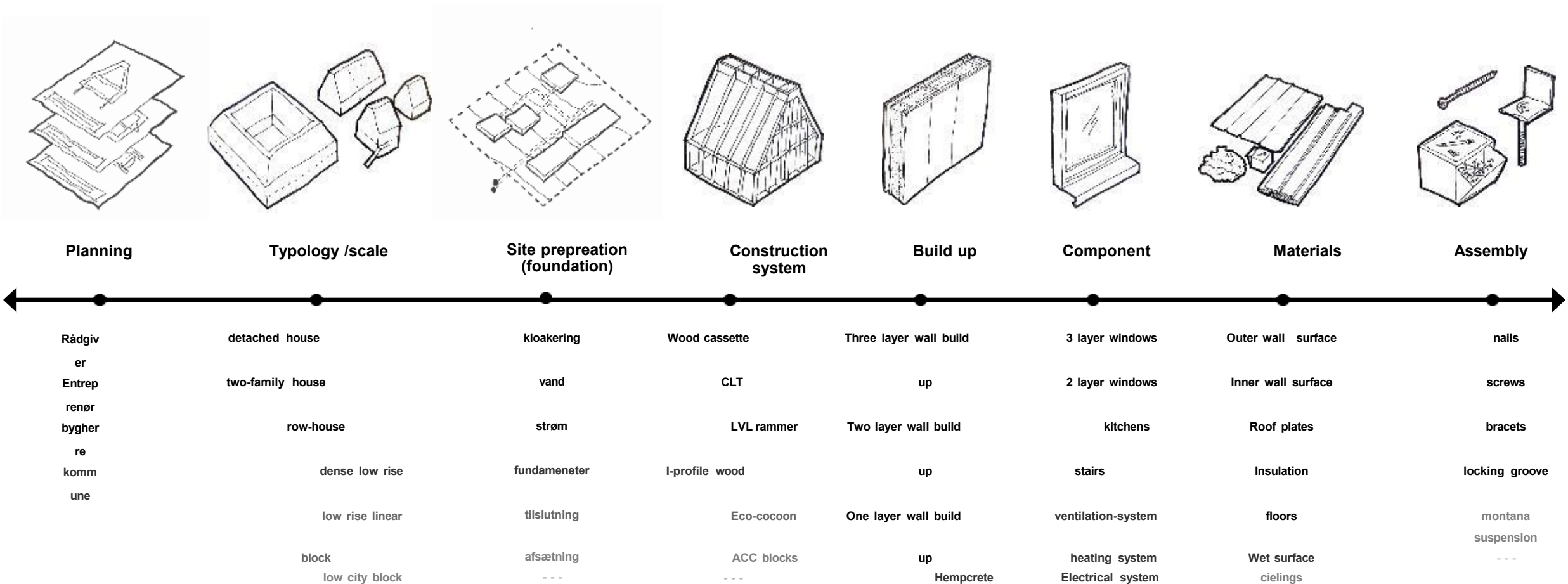


**Development  
project**

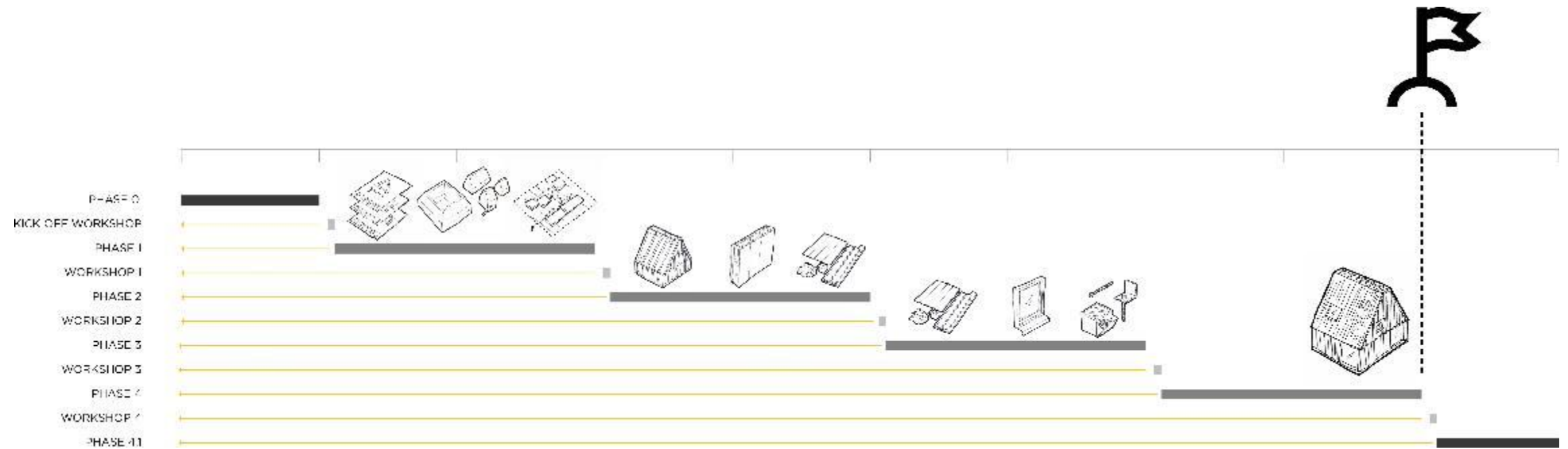
# Optimization process

## Subjects

We have proposed various subjects to look into, in order to guide the process.



## Process plan Development project



# How we benchmark and select

# Optimization process Relevant subjects

Based on the compass model we have to ensure benchmarking on multiple subjects to ensure that the project does not compromise its holistic approach.

Compass Model



Compass Model

**Affordable**

Material cost  
Labor cost  
Operation cost  
etc.

**Flexible**

Process  
Buildability  
Reconfigurations  
etc.

**Quality**

Durability  
Ease of use  
etc.

**Environment**

Embodied CO2  
Operational CO2  
etc.

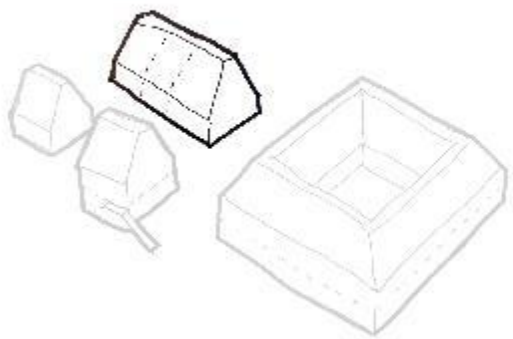
**Health**

Daylight  
IAQ  
Thermal environment  
Noise  
etc.

# Process for optimization: example

To ensure we effectively bring everyone's knowledge to the table we propose a methodology that enables us to screen these subjects fast and efficiently. This will give us a quick overview on what directions we should pursue in depth to enable a price reduction without compromising on Environmental impact, and indoor environment.

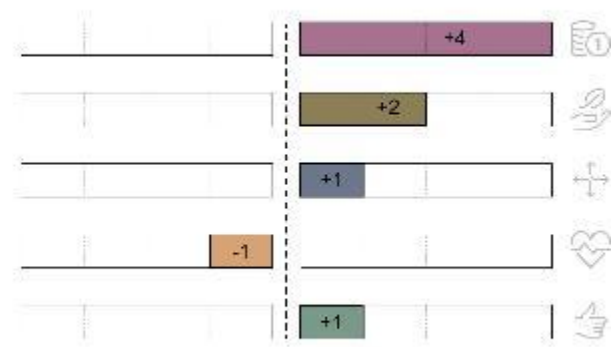
Subject  
Rowhouse



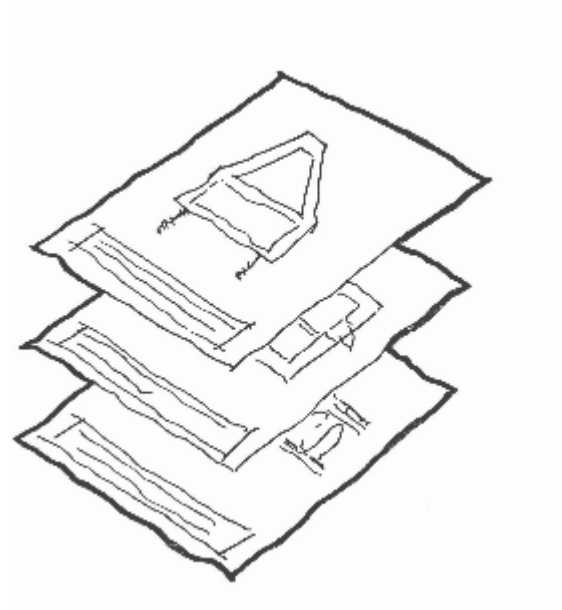
Compass Model



Technical Estimations



# Optimization Advise and findings

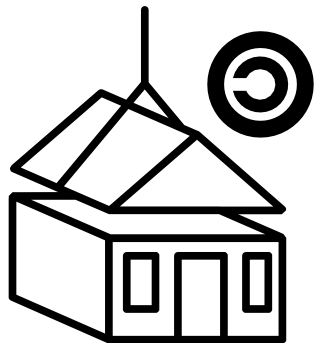


**PLANNING**



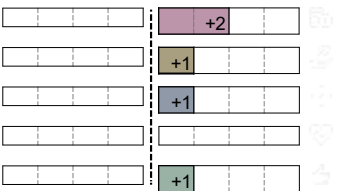
# Planning

Having used the process described above, we have come up with some advice for how we can bring down price and LCA whilst keeping, or increasing the healthy indoor environment. These are the sections of the best examples we have chosen and where we can influence the most.



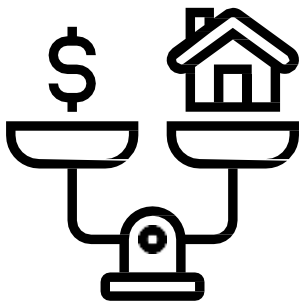
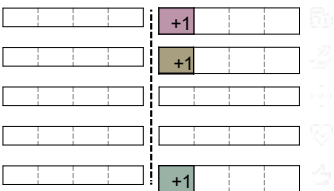
## Copyleft concept

is based on a similar approach to enable rapid scalability as the typehouse companies, we can lower prices from architects, engineers and entrepreneurs significantly, by having developed typologies that can scale to multiple locations, all based on the same KPI's and building systems. We estimate that we can reduce price pr. m2 from architect and engineers with up to 5-25% depending on the projects location and if its can be based in prexcisting work.



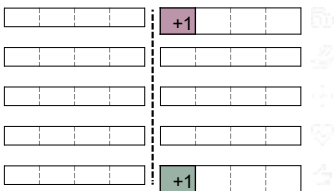
## Fire engineer (for typologies)

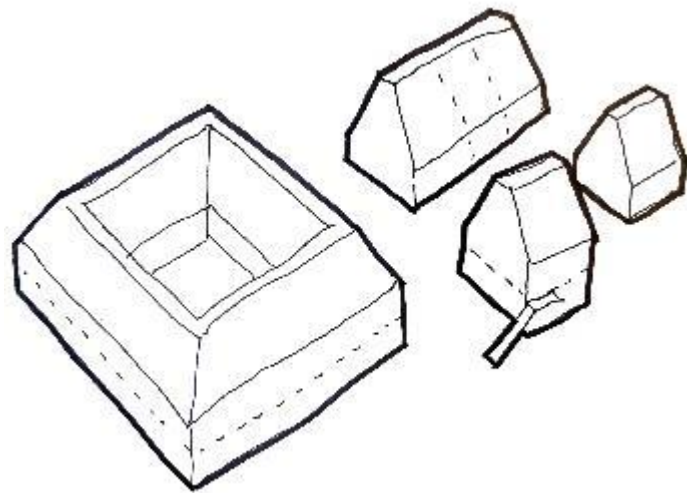
To enable lower price and lower LCA typologies money should be spent up front to have a fire engineer okay the non pre-accepted solution, this will enable a lower LCA and price. Simultaneously it enables us to scale these solutions, without a minimal risk.



## Avoid functioning tendering (funktions udbud)

With the high ambitions to reduce the environmental impact of Living Places, it is important to maintain control over which materials and products are used in construction. Products with the same technical quality can have very different environmental impacts depending on the production method and location, which is why the final CO2 performance of the construction is strongly dependent on product choice. In the case of function tenders, it is difficult to set requirements for the use of specific products, as only the function is required, and not the environmental profile, and it is therefore necessary to avoid this type of tender.





**Typology / scale**



Scaling both up and down in relation to the original typology, we have investigated a range of building heights from 2-5 floors. Looking at LCA and price, together with fire regulations and other relevant subjects. The limit of 5 floors is kept to maintain the fireregulations low - thus making it possible to keep a low LCA in combination with a low price.



( Original )



|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |

The diagram illustrates the addition and subtraction of 100 from 1000 using 10x10 grids. Each grid is divided into two sections by a vertical dashed line: a top section of 2 rows by 5 columns, and a bottom section of 3 rows by 5 columns.

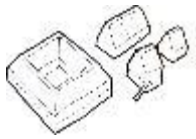
- Row 1:** 1000 (purple) + 100 (purple) = 1100 (purple). The top section is fully shaded purple, and the bottom section is also fully shaded purple.
- Row 2:** 1000 (white) - 100 (brown) = 900 (white). The top section is white, and the bottom section is white with the first two columns shaded brown.
- Row 3:** 1000 (white) + 100 (blue) = 1100 (blue). The top section is white, and the bottom section is white with the first two columns shaded blue.
- Row 4:** 1000 (white) - 100 (orange) = 900 (white). The top section is white, and the bottom section is white with the first two columns shaded orange.

Icons on the right include a calculator, a plus sign, a minus sign, a multiplication sign, a division sign, and a percentage sign.

The diagram illustrates the addition of two negative integers,  $-1$  and  $-2$ , using a number line and a grid. The number line shows  $-1$  and  $-2$ , and the grid shows 10 units, with 2 units shaded purple and 1 unit shaded blue, totaling 3 units.

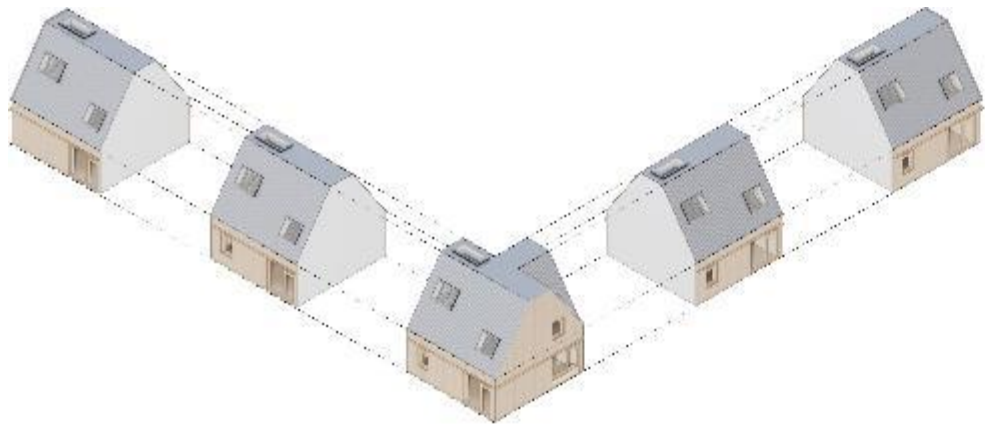
The diagram illustrates a sequence of 10 number lines, each with tick marks from -3 to 3. The first five number lines are on the left, and the next five are on the right, separated by a dashed vertical line. The first number line on the left is empty. The second has a pink box with '+1' at 1. The third has a green box with '+2' at 2. The fourth has a blue box with '+1' at 1. The fifth has an orange box with '-1' at -1. The sixth number line on the right is empty. The seventh has a green box with '+1' at 1. The eighth is empty. The ninth is empty. The tenth is empty.

The diagram illustrates the addition of integers using a number line. It shows a horizontal number line from -10 to 10. A purple box labeled '+2' is placed on the line, starting from 0 and ending at 2. A green box labeled '+1' is placed on the line, starting from 2 and ending at 3. The final result is 3, indicated by a green box labeled '+3' at the end of the number line.



# How we divided the building

Together with the scale in height, we developed a modular thought for adding buildings in rows or courtyards, while still keeping track of LCA and price and making an optimized building system without one-off solutions.



|  |    |    |  |  |
|--|----|----|--|--|
|  |    | +3 |  |  |
|  |    | +2 |  |  |
|  |    | +1 |  |  |
|  | -1 |    |  |  |
|  |    |    |  |  |

# Typologies

|              | 2 levels                                                                            | 3 levels                                                                            | 3 levels (2 units)                                                                   | 4 levels (2 units)                                                                    | 4 levels (3 units)                                                                    | 5 levels (3 units)                                                                    |
|--------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Middle-house |    |    |    |    |    |    |
| Gable-house  |    |    |    |    |    |    |
| Corner-house |  |  |  |  |  |  |



To further broaden the scalability of the system, we ensured that the building system could be scaled into various sizes.

**2 levels**  
**80 m2**

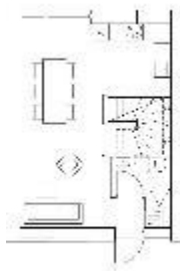
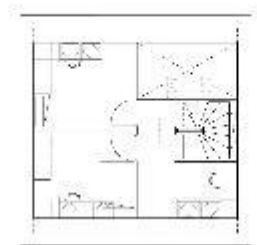


Diagram illustrating the addition of two 2x2 matrices:

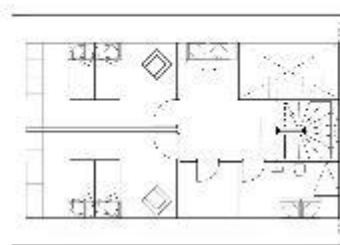
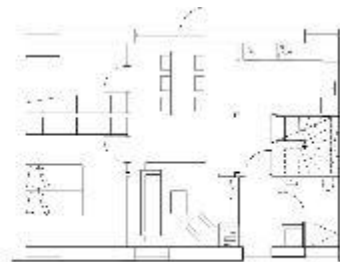
$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} + \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} 0 & 2 \\ 3 & 3 \end{bmatrix}$$

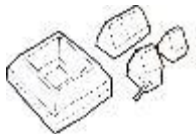
**2 levels**  
**105m2**



|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | + | 3 | 4 | 1 | 2 | + | 3 | 4 |
| 1 | 2 | + | 3 | 4 | 1 | 2 | + | 3 | 4 |
| 2 | 3 | + | 4 | 5 | 2 | 3 | + | 4 | 5 |
| 2 | 3 | + | 4 | 5 | 2 | 3 | + | 4 | 5 |
| 3 | 4 | + | 5 | 6 | 3 | 4 | + | 5 | 6 |
| 3 | 4 | + | 5 | 6 | 3 | 4 | + | 5 | 6 |
| 4 | 5 | + | 6 | 7 | 4 | 5 | + | 6 | 7 |
| 4 | 5 | + | 6 | 7 | 4 | 5 | + | 6 | 7 |
| 5 | 6 | + | 7 | 8 | 5 | 6 | + | 7 | 8 |
| 5 | 6 | + | 7 | 8 | 5 | 6 | + | 7 | 8 |
| 6 | 7 | + | 8 | 9 | 6 | 7 | + | 8 | 9 |
| 6 | 7 | + | 8 | 9 | 6 | 7 | + | 8 | 9 |
| 7 | 8 | + | 9 | 0 | 7 | 8 | + | 9 | 0 |
| 7 | 8 | + | 9 | 0 | 7 | 8 | + | 9 | 0 |
| 8 | 9 | + | 0 | 1 | 8 | 9 | + | 0 | 1 |
| 8 | 9 | + | 0 | 1 | 8 | 9 | + | 0 | 1 |
| 9 | 0 | + | 1 | 2 | 9 | 0 | + | 1 | 2 |
| 9 | 0 | + | 1 | 2 | 9 | 0 | + | 1 | 2 |
| 0 | 1 | + | 2 | 3 | 0 | 1 | + | 2 | 3 |
| 0 | 1 | + | 2 | 3 | 0 | 1 | + | 2 | 3 |

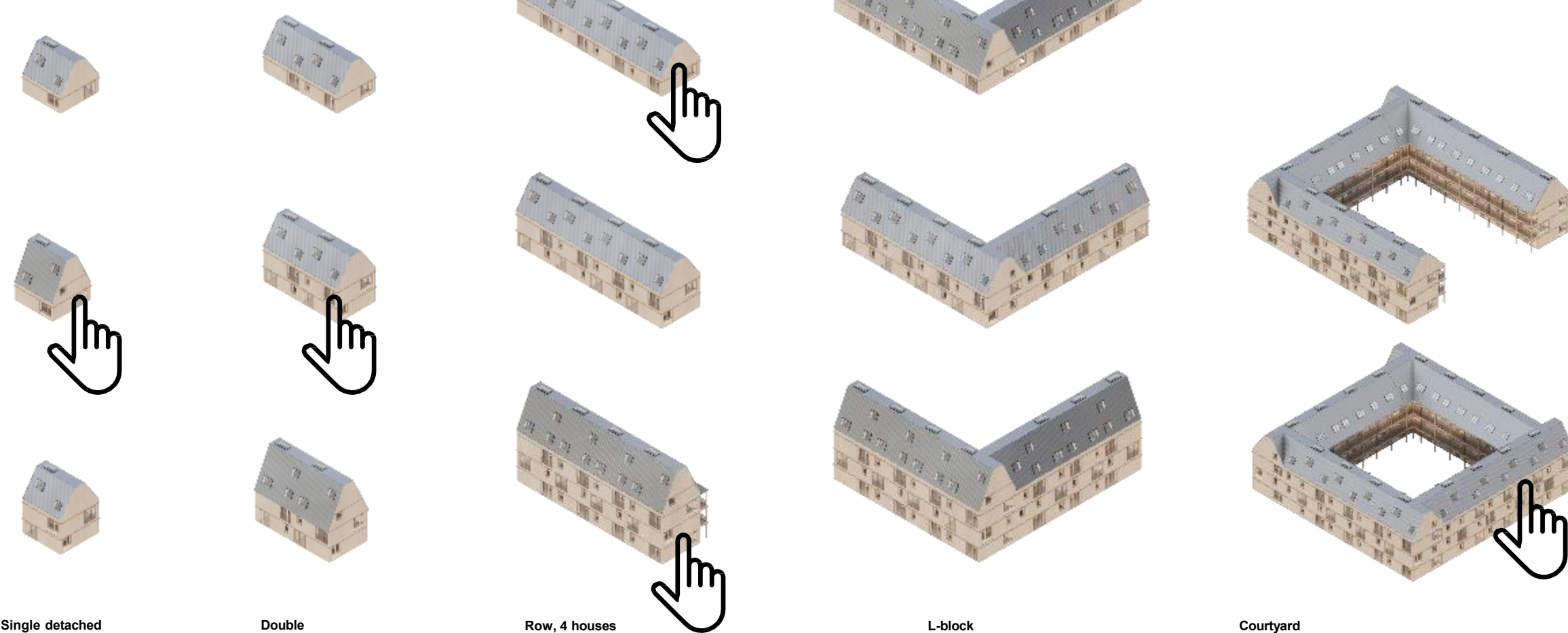
**2 levels**  
**150 m2**





# Selected typologies to investigate

Having used the process described above, we have developed new typologies that enable us to bring down price and LCA whilst keeping, or increasing the healthy indoor environment. These typologies are investigating which ones would be the best suited for further development.



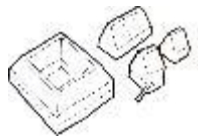
Single detached

Double

Row, 4 houses

L-block

Courtyard



# Plans & revisions

To ensure we could use this method we also created plans, this served both as a way to ensure we could create plans that were good in all scales and that we could create plans that could expand and increase.



2 floor  
Detached  
house



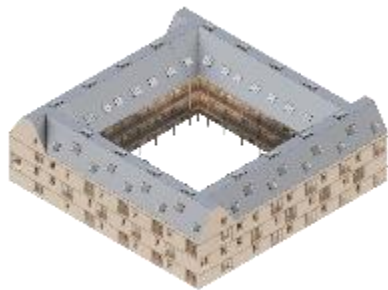
3 floor  
Row  
house



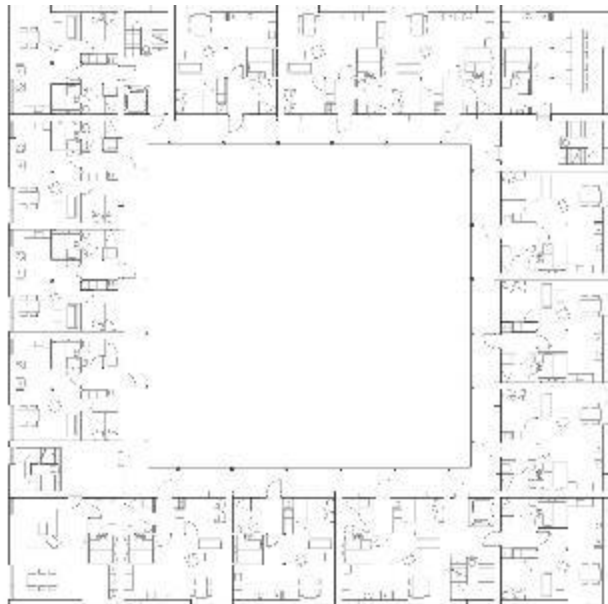
2 floor  
Row  
house

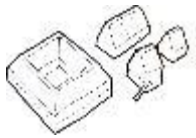


5 floor  
Linear  
housing



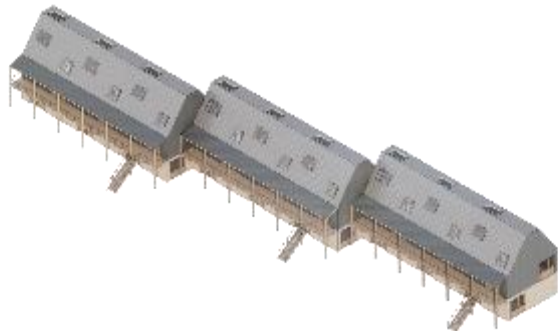
4 floor  
courtyard  
housing





# Scale breakdowns and diveristy studies

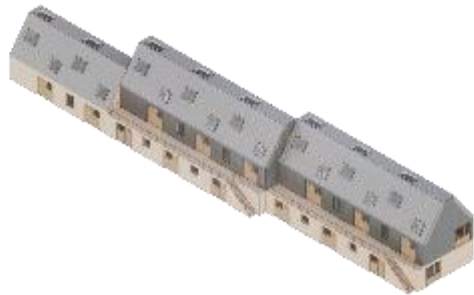
Investigation into how we can combine the various modules and how it affects the esthetics, price and LCA.



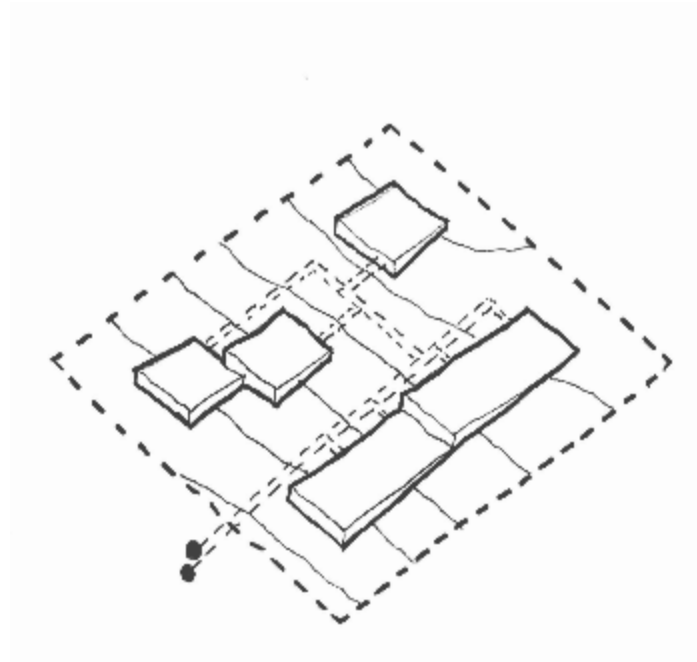
Invesigation into how typologies can be shifted to breakdown the scale



Invesigation into how we can mix heights and accessability, to breakdown scale and inhance density



Investigation into how we can breakdown scale by shifting typolgies while mixing typology heights

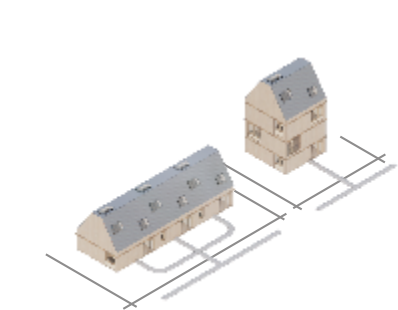


**Site / preparation**



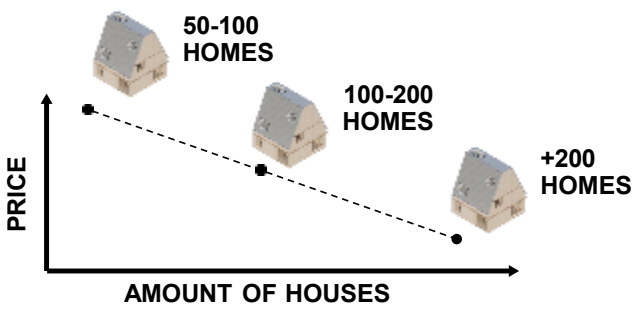
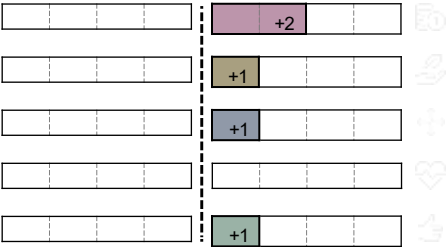
# Site preparation

Having used the process described above, we have developed some principles and investigation possibilities for how we can reduce price and LCA and increase healthy building principles.



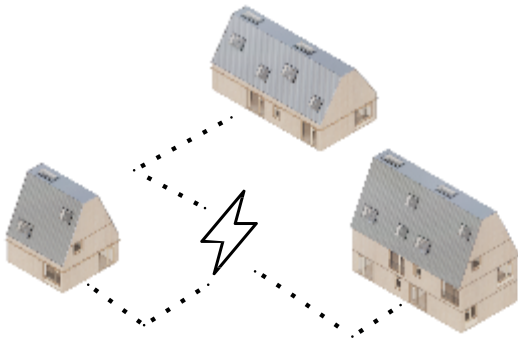
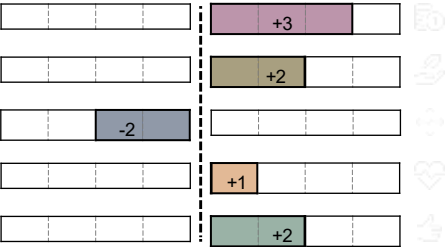
## Shared sites boundary (fælles matrikel)

By creating a shared boundary we only have to pay for one connection to the electricity grid, water grid, sewage etc. This reduces price and makes it more flexible and easy to construct.



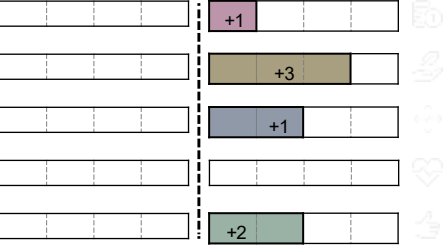
## Sytems design = scalability & lowered cost

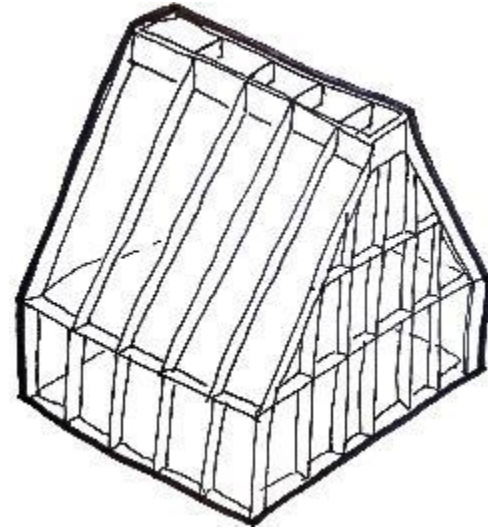
In order to ensure we deliver on the vision and mission, we have to create a system and thereby we are able to create scalability since, we can repeat and buy materials in bulk and set up partnerships. Depending on which scenarios we choose the price fluctuate.  
Scenario 1: 50-100 homes: There are most business plots in the market - where a setup to this extent can be realized. Scenario 2: 100-200 homes: The repetition effect is large, which is why this setup is considered potentially cheaper than the realization of scenario 1. Scenario 3: +200 homes: The repetition effect is large, which is why this setup is considered potentially cheaper than the realization of scenario 1.



## Energy communities

By planning for an energy community, we can reduce both emission and price compared to using individual heat pumps or district heating.





**Construction system**



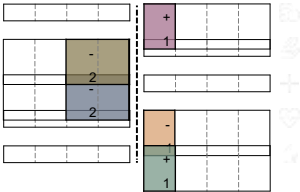
# Construction system

To ensure we effectively bring everyone’s knowledge to the table we propose a methodology that enables us to screen these subjects fast and efficiently. This will give us a quick overview on what directions we should pursue in depth to enable a price reduction without compromising on Environmental impact, and indoor environment.

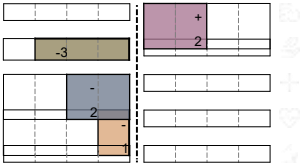
## Block System



Brick system



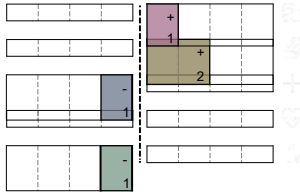
Concrete block



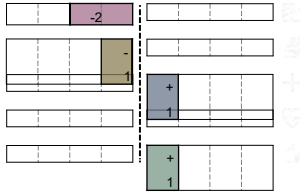
## Wood Construction System



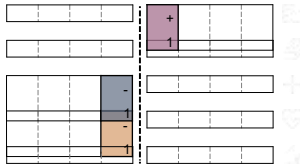
I-beams wood cassette



CLT



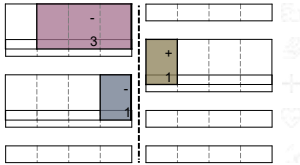
LVL-system



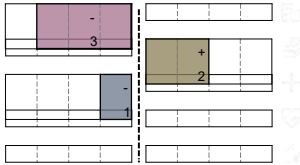
## Composite System



Straw (ecococoon)



Hempcrete





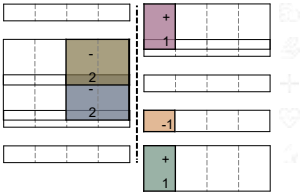
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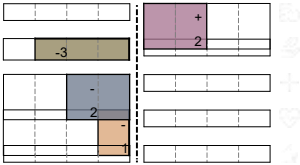
## Block System



Brick system



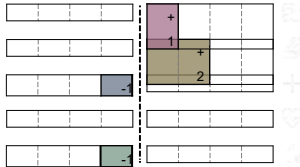
Concrete block



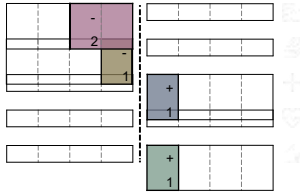
## Wood Construction System



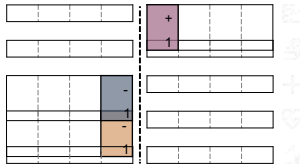
I-beams wood cassette



CLT



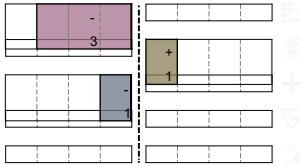
LVL-system



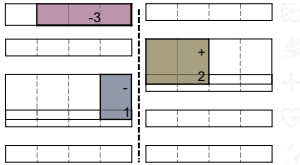
## Composite System

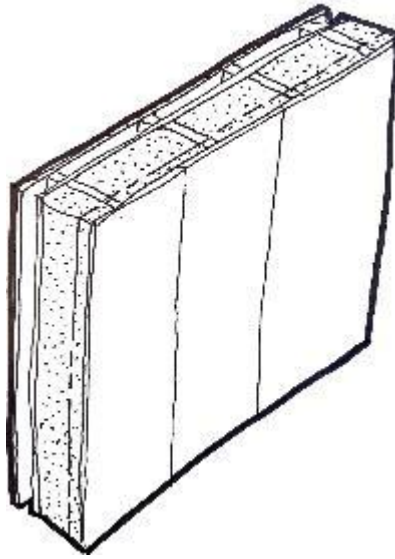


Straw (ecococoon)

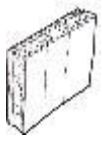


Hempcrete





**Build-up**



# Build-up

By using the process, we have investigated various build ups. We have developed LCA, prices and detailed drawing for numerous versions. This catalog can be expanded and serves as a knowledge bank for the team.



01

## Fundation

Deck  
Pillars  
Etc



02

## Terrain deck

Structure  
Insulation  
Flooring



03

## Outerwalls

Strucutre  
Insulation  
Facade



04

## Floor build-up

Structure  
Insulation  
Flooring



05

## Inner walls

Structure  
Insulation  
Finishes

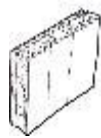


06

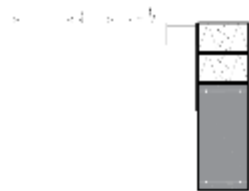
## Roof build-up

Structure  
Insulation  
Finishes

# Build-up Foundation

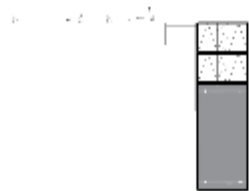


Traditional foundation  
Leca and concrete



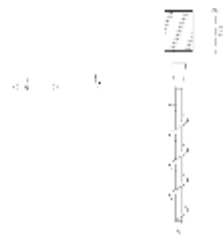
450 x 600 mm concrete C15 incl. reinforcement (Celsa Steel)  
2 pcs. Lecaterm blocks  
10 mm plaster

Traditional foundation  
Future cement



450 x 600 mm concrete C15 with FutureCem incl. reinforcement (Celsa Steel)  
2 pcs. Lecaterm blocks  
10 mm plaster

Elevated screw pile foundation



Krinner screw foundations in steel, 36 kg / pc.  
Incl. glulam strap: 2 pcs. 266x185 and 2 pcs 200x185 mm

L-element



L-element from Sundolit  
Concrete filling C15 with FutureCem  
Screws for holding, 36 kg / pc





# Build-up Foundation

Traditional foundation  
Leca and concrete



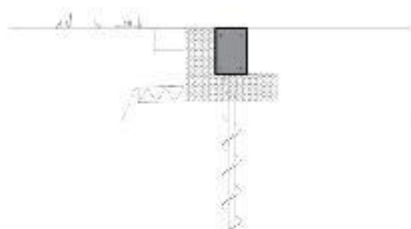
Traditional foundation  
Future cement



Elevated screw pile foundation



L-element



1. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
2. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
3. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)

1. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
2. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
3. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)

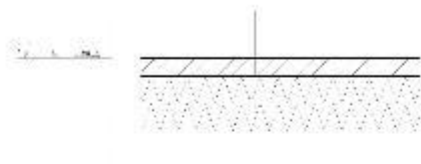
1. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
2. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
3. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)

1. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
2. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)  
3. 100x100x100 Leca (12m x 40cm x 40cm) (12m x 40cm x 40cm)



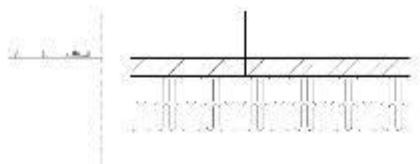
Values: 3 floors - 1 unit - Middle element

Concrete deck  
on polystyrene



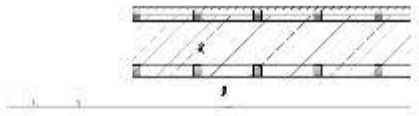
120 mm concrete slab layer C15 with FutureCem incl. reinforcement (Celsa Steel)  
360 mm polystyrene S80, kl. 38  
50 mm screed in sand / sand pad

Concrete deck  
on Rockwool terrain bats



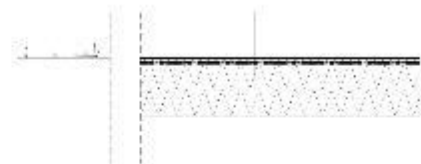
120 mm concrete slab layer C15 with FutureCem incl. reinforcement (Celsa Steel)  
360 mm Rockwool Terrain Batts, at 38  
50 mm screed in sand / sand pad

Raised light deck  
paper insulation



22 mm chipboard, waterproof (Kronospan)  
45x70 mm batten C18 - c / c 400 mm  
70 mm Paper wool granules, at 37, fire class B-s2, d0  
0.2 mm vapor barrier / vapor brake  
45x295 Construction wood, c / c 600 mm  
295 mm Paper wool granules, kl. 37, fire class B-s2, d0  
8 mm hard wind barrier at 1 Windstopper Extreme

Light deck  
on polystyrene

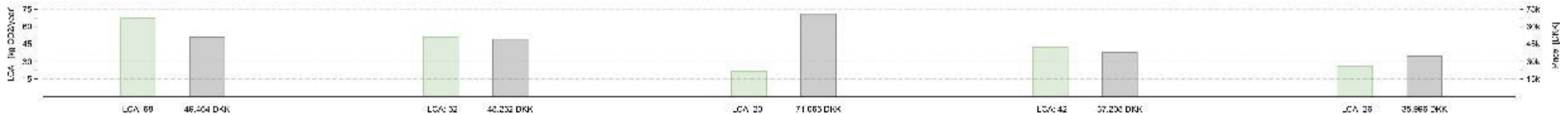


22 mm chipboard, waterproof (Kronospan)  
0.2 mm vapor barrier / vapor brake  
360 mm polystyrene S80, at 38  
50 mm screed in sand / sand pad

Light deck  
on Rockwool terrain bats



22 mm chipboard, waterproof (Kronospan)  
0.2 mm vapor barrier / vapor brake  
360 mm Rockwool Terrain Batts  
50 mm screed in sand / sand pad





Build-up  
Terrain deck

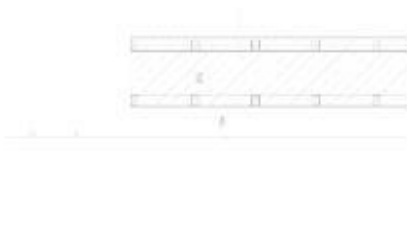
Concrete deck  
on polystyrene



Concrete deck  
on Rockwool terrain bats



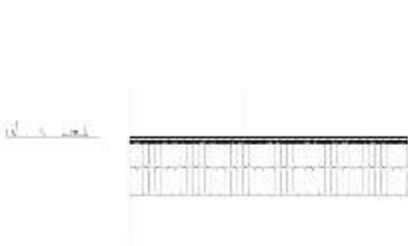
Raised light deck  
paper insulation



Light deck  
on polystyrene



Light deck  
on Rockwool terrain bats



LC  
A

Price  
[excl.  
DB]

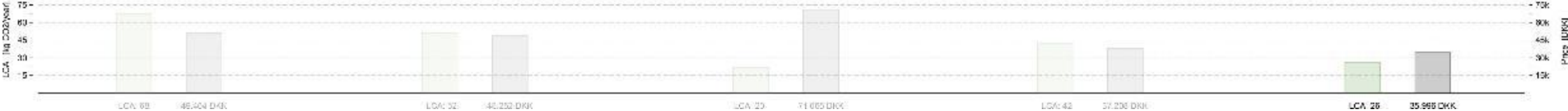
120 mm concrete slab (type G, 15 m³) (Polar-Green) incl. formwork  
(120 m² floor)  
360 mm polystyrene (150 kg) 30  
50 mm slotted metal mesh (100 m²)

120 mm concrete slab (type G15 with Poptulac) incl. formwork  
(120 m² floor)  
330 mm Rockwool Terrain Bats w 25  
83 mm mineral wool (150 m²)

27 mm diphasic insulation (100 m² floor)  
45/70 mm paper (115 m² x 50 m)  
70 mm paper insulation (100 m² floor)  
62 mm slotted metal mesh (100 m² floor)  
45/85 mm paper (100 m² floor)  
135 mm paper insulation (100 m² floor)  
6 mm paper insulation (100 m² floor)

27 mm diphasic insulation (100 m² floor)  
45/70 mm paper (115 m² x 50 m)  
70 mm paper insulation (100 m² floor)  
62 mm slotted metal mesh (100 m² floor)  
45/85 mm paper (100 m² floor)  
135 mm paper insulation (100 m² floor)  
6 mm paper insulation (100 m² floor)

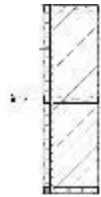
27 mm diphasic insulation (100 m² floor)  
45/70 mm paper (115 m² x 50 m)  
70 mm paper insulation (100 m² floor)  
62 mm slotted metal mesh (100 m² floor)  
45/85 mm paper (100 m² floor)  
135 mm paper insulation (100 m² floor)  
6 mm paper insulation (100 m² floor)



Values: 3 floors - 1 unit - Middle element

# Built-up Exterior wall

Timber frame structure  
with glass wool



8 mm Windstopper Extreme (Cembritt)  
45x295 mm studs, K18 c / c 600 mm  
295 mm glass wool, at 34 - bats (Isover)  
18mm OSB board  
45x70 mm studs c / c 450 mm  
45 mm glass wool at 34 (Isover)  
15 mm fiberglass

Timber frame structure  
with paper wool insulation



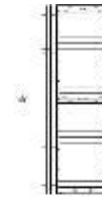
8 mm Windpanel Premium (diffusion open)  
45x295 mm studs, K18 c / c 600 mm  
295 mm paper wool insulation, at 37 - Granulate fire class B-s2, d0 (IsoCell)  
18mm OSB plate G3  
45x70 mm studs c / c 450 mm  
45 mm wood fiber bats, at 38 fire class B-s2, d0 (Woodfiber)  
15 mm fiber gypsum board cladding with tongue / groove joint

Timber frame structure I-beam  
with wood fiber insulation



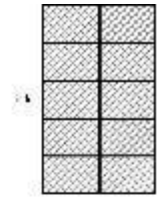
8 mm Windpanel Premium (diffusion open)  
300 mm I-beams c / c 600 mm (Masonite Beams)  
300 mm wood fiber insulation, at 38 - Granules (Hunton)  
18mm OSB plate G3  
45x70 mm studs c / c 450 mm  
45 mm wood fiber insulation, at 38 (Hunton)  
15 mm fiber gypsum board cladding with tongue / groove joint

CLT  
with paper wool insulation

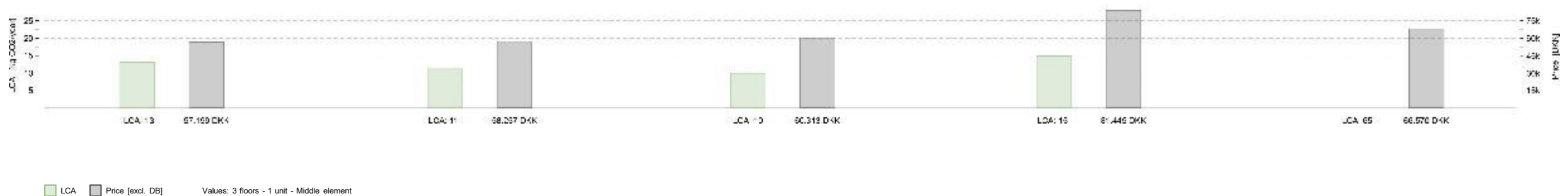


8 mm Windstopper Extreme (Cembritt)  
45x345 mm I-beams c / c 600 mm  
345 mm insulation, paper wool, at 37 -granules  
100 mm CLT (Sódra)

Cell block brick



2 x 365 mm insulated cell blocks (Thermoplan)





Build-up  
Exterior wall

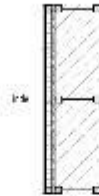
Timber frame structure  
with glass wool



Timber frame structure  
with paper wool insulation



Timber frame structure I-beam  
with wood fiber insulation



CLT  
with paper wool insulation



Cell block brick



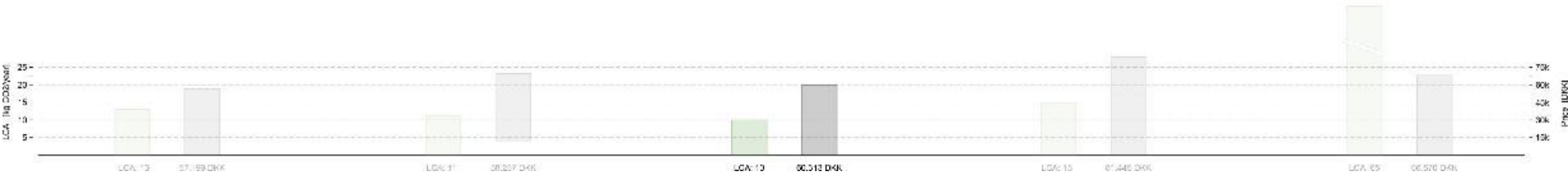
LC A Price  
excl. DBI  
8 mm Glass wool (Fiberglas-Glaswolle)  
45x70 mm glass wool (Fiberglas-Glaswolle)  
45 mm glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool

8 mm Glass wool (Fiberglas-Glaswolle)  
45x70 mm glass wool (Fiberglas-Glaswolle)  
45 mm glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)

8 mm Glass wool (Fiberglas-Glaswolle)  
45x70 mm glass wool (Fiberglas-Glaswolle)  
45 mm glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)

8 mm Glass wool (Fiberglas-Glaswolle)  
45x70 mm glass wool (Fiberglas-Glaswolle)  
45 mm glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)  
15 mm Glass wool (Fiberglas-Glaswolle)

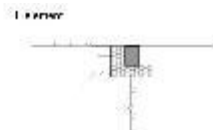
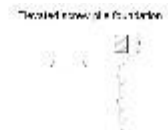
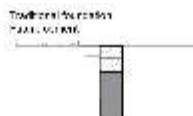
15 mm Glass wool (Fiberglas-Glaswolle)



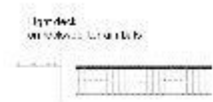
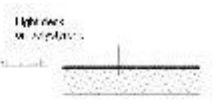
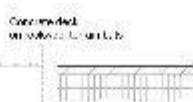
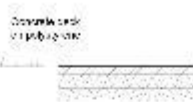
Values: 3 floors - 1 unit - Middle element

# Bui-up Over view

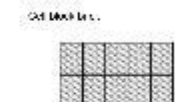
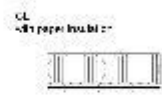
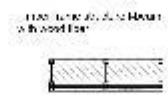
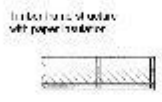
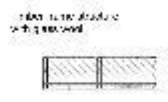
Foundation



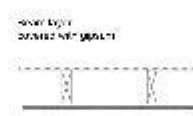
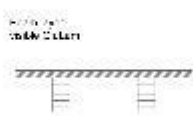
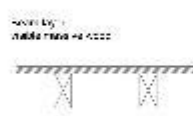
Terrain-deck



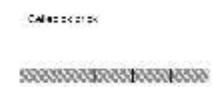
Outerwall



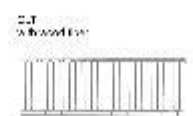
Floor build-up



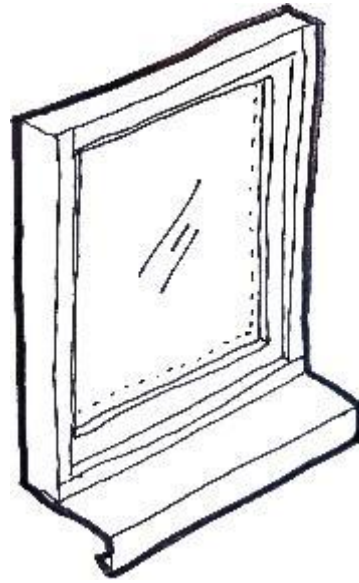
Inner walls



Roof build-up



↓ AND MORE ↓



**Components**



## Components

Add on - building elements



### ADD ON - BUILDING COMPONENTS

In order to ensure maximum flexibility and the ability to comply with building regulations we have created a list of building components and benchmarked these against the 5 points, to ensure compliance with the overall mission for the concept.



### TECHNICAL COMPONENTS

In order to ensure maximum flexibility and the ability to comply with building regulations we have created a list of technical components and benchmarked these against the 5 points, to ensure compliance with the overall mission for the concept.



# Components

## Add on - building components



**Exterior access stair**

- o Wood
- o Steel



**Roof eaves**

- Roof eaves - big (1,5 m)
- o Steel roof
  - o Roofing film + photovoltaics
  - o Green roof
- Roof eaves - small (0,5 m)



**Balcony access**

- Column - Beam
- o Wood
  - o Steel
- Foundations
- o Concrete
  - o Screw foundation
- Balcony access deck
- o High strength concrete
  - o Woodconstruction (fireprotected)
  - o Steelconstruction (fireprotected)
- Railing
- o Steel
  - o Wood



**Stairwell**

- Walls (firesection)
- o CLT
  - o Concrete



**Shed / Technical room**

- Wood, non-insulated
- Wood, insulated

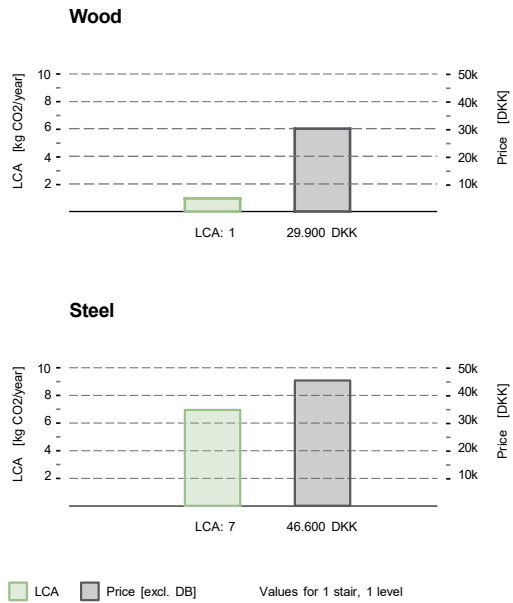


Comments

Exterior access stair



Exterior access stair





# Components

## Exterior access stair



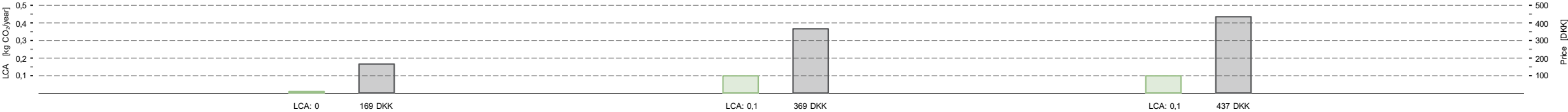
Exterior access stair



Exterior access stair + balcony access + shed



Exterior access stair + balcony access + roof eaves



 LCA  Price [excl. DB]

LCA and price is calculated for a 3 level (165 m2) middle house, and should be added to the values of the house.



# Components

## Roof eaves



Roof eaves - small (0,5 m)



Roof eaves - big (1,5 m)



Balcony access



# Components

## Roof eaves



Roof material



Green roof



Photovoltaic

# Comments

## Balcony access

### Roof overhang 01:

- Sinus plates, steel zinc magnesium
- Spruce roof battens 38x73 pr 400mm
- Rafters, solid timber 100x200 pr 1000mm

### Roof overhang 02:

- Green roof or solar panels
- Roofing paper membrane
- 25mm plywood
- 8 Mm hard wind barrier kl. 1 Cembrit extreme
- 45x125mm planks -c / c 300 mm

### Balcony access deck 01, 02 & 03

See build-ups on next page

### Railing 01: (steel)

- Galvanized flat steel 8x50mm frames 1950x1200
- Galvanized round steel ø 8mm per 75mm

### Railing 02: (wood)

- Handrail: 100x40mm, core pine
- Posts: 100x40 pr. 975mm, core pine
- Core pine 20x50 mm pr 75mm

### Column-beam system 01 - wood

- Columns: 180x180 mm GL28H
- Visible beams: 180x180 mm GL28H

### Column-beam system 02 - steel

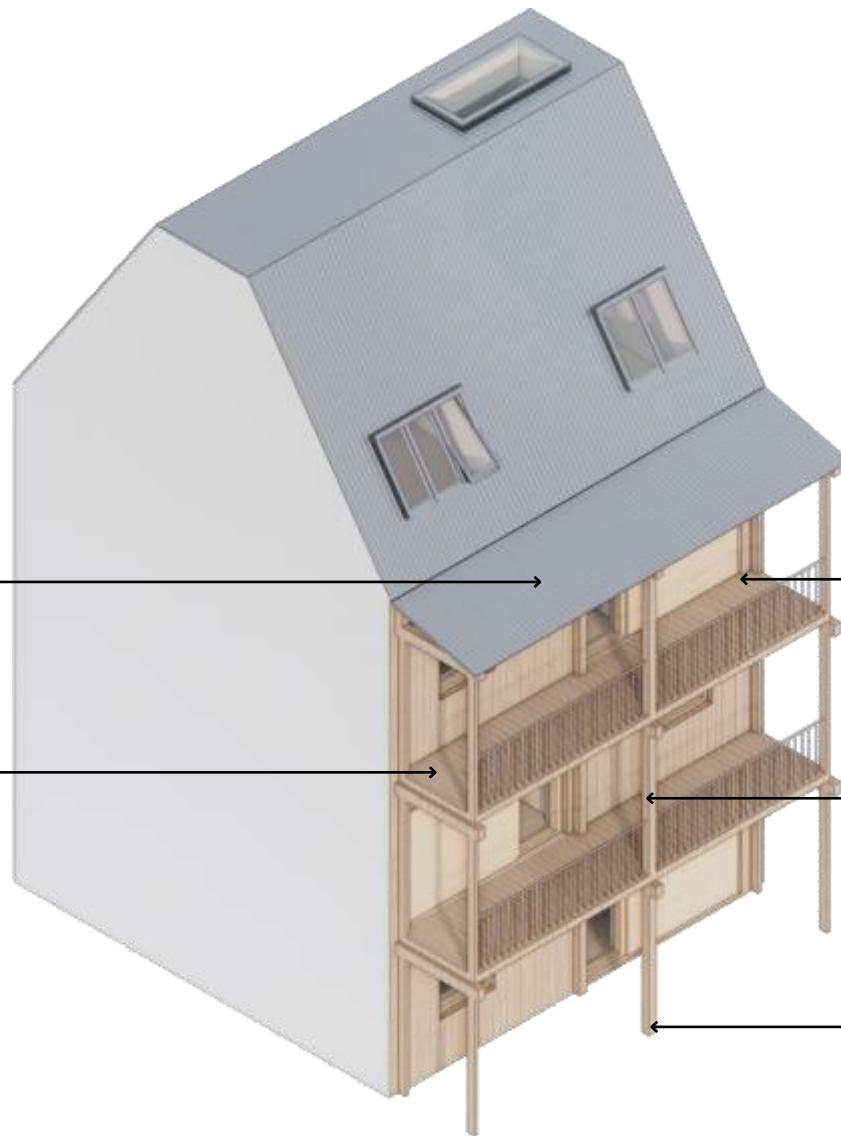
- Columns: HE120A
- Frame: UNP160

### Foundation 01

- Point foundation 1x1x1 meter with steel angle for distance to ground

### Foundation 02

- Screw foundation, same as for housing





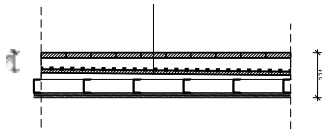
Comments

Balcony access



Balcony acces - steel

- Foundation**
- Point foundation 1x1x1 meter
  - Steel angle for distance to ground
- Column-beam system in steel**
- Columns: HE120A
  - Frame: UNP160
- Balcony access deck**
- 32 mm terrace boards, spruce
  - 45x150 mm wood construction
  - Plywood, roofing film
  - UNP 80 per 0.5 m
  - 2x15 mm fireboard
- Railing in steel**
- Galvanized flat steel 8x50mm frames 1950x1200
  - Galvanized round steel ø 8mm per 75mm

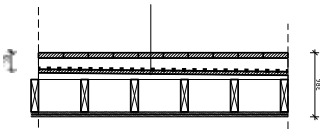


LCA: 1,7      5.114 DKK



Balcony acces - wood

- Foundation**
- Screw foundation, same as for housing
- Column-beam system in wood**
- Columns: 180x180 mm GL28H
  - Visible beams: 180x180 mm GL28H
- Balcony access deck**
- 32 mm terrace boards, spruce
  - 45x150 mm wood construction
  - Plywood, roofing film
  - 45x195 mm plywood C18 per 300 mm
  - 2x15 mm fireboard
- Railing in wood**
- Handrail: 100x40mm, core pine
  - Posts: 100x40 pr. 975mm, core pine
  - Core pine 20x50 mm pr 75mm

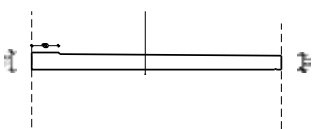


LCA: 0,8      3.242 DKK

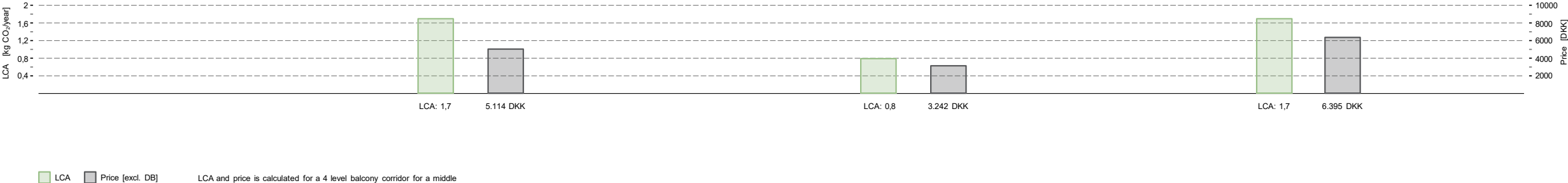


Balcony acces - high-strength concrete

- Foundation**
- Screw foundation, same as for housing
- Column-beam system in wood**
- Columns: 180x180 mm GL28H
  - Visible beams: 180x180 mm GL28H
- Balcony access deck**
- Fiber concrete
- Railing in steel**
- Galvanized flat steel 8x50mm frames 1950x1200
  - Galvanized round steel 8mm per 75mm



LCA: 1,7      6.395 DKK

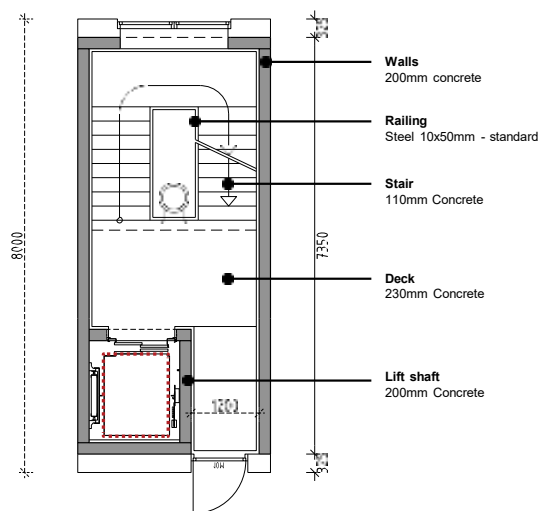


# Components

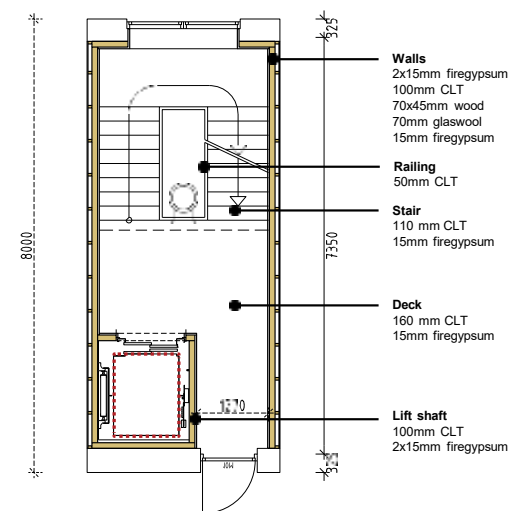
## Stairwell



### Concrete



### CLT





## Comments

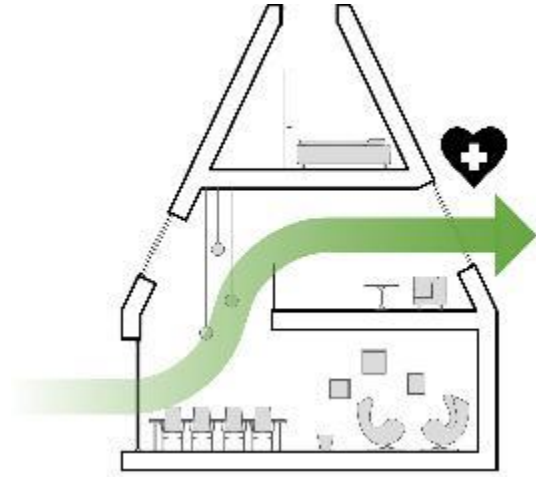
### ADD ON - BUILDING COMPONENTS

In order to ensure maximum flexibility and the ability to comply with building regulations we have created a list of building components and benchmarked these against the 5 points, to ensure compliance with the overall mission for the concept.



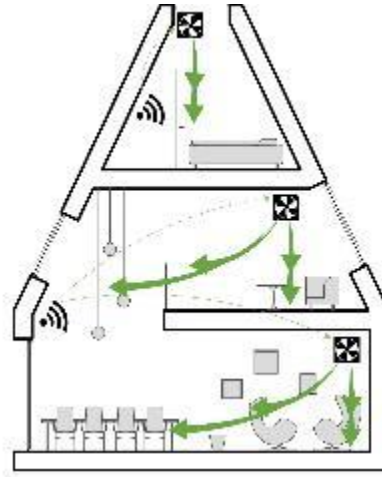
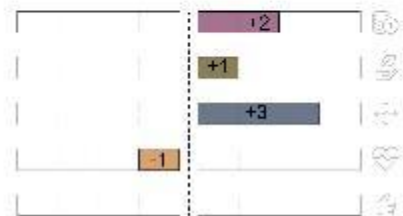
## TECHNICAL COMPONENTS

In order to ensure maximum flexibility and the ability to comply with building regulations we have created a list of technical components and benchmarked these against the 5 points, to ensure compliance with the overall mission for the concept.



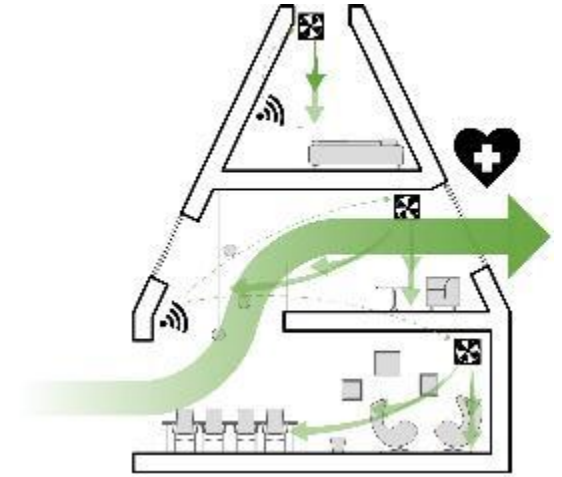
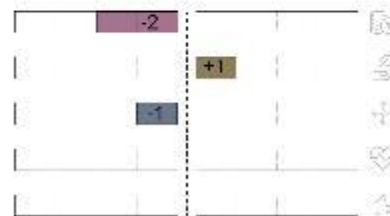
### NATURAL VENTILATION

House that only has natural ventilation



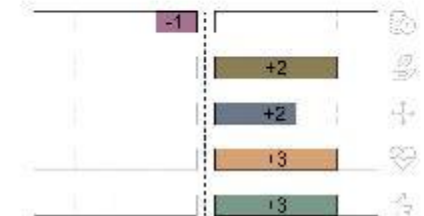
### MECHANICAL VENTILATION

House that only has mechanical ventilation



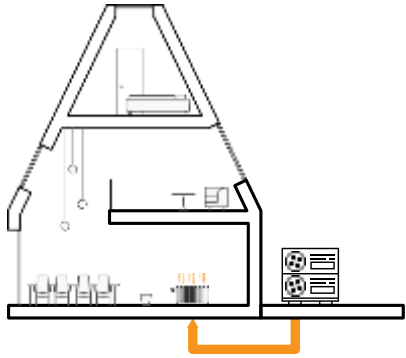
### HYBRID VENTILATION

House that only both natural and mechanical ventilation that interacts, using each others strengths.



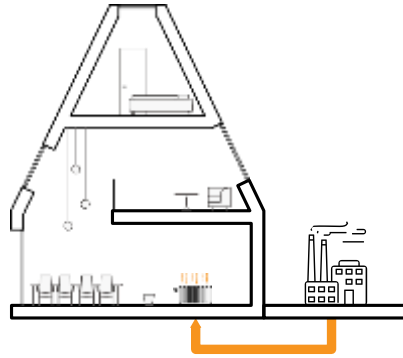
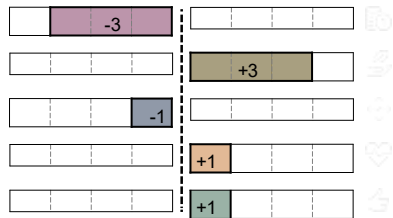
# Comments

## Heating system



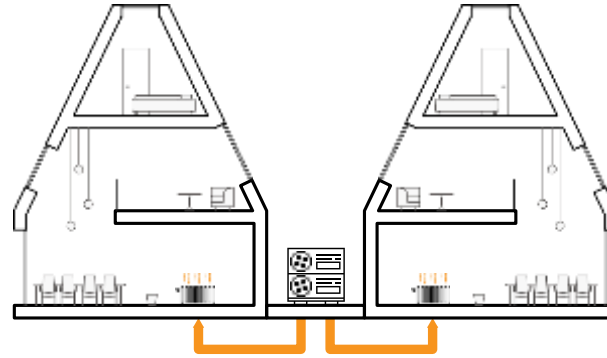
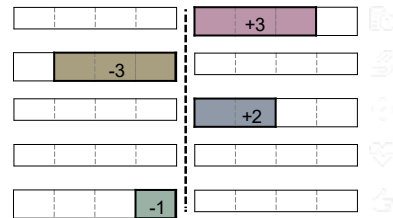
### INDIVIDUAL HEAT PUMP - AIR TO WATER

Performance benchmarked based  
on individual heat pump



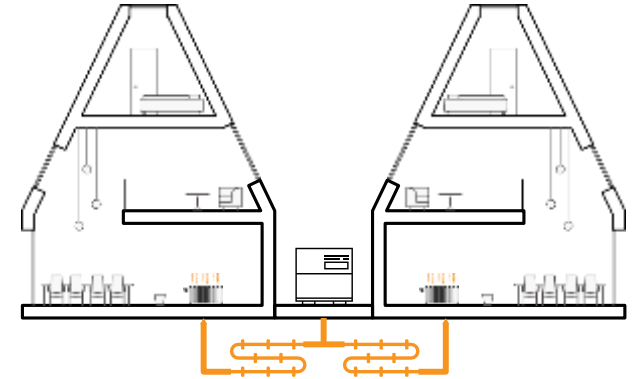
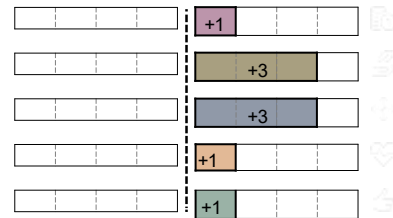
### DISTRICT HEATING

Performance benchmarked based  
on district heating



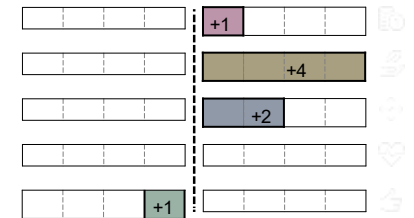
### ENERGY COMMUNITY HEAT PUMP - AIR TO WATER

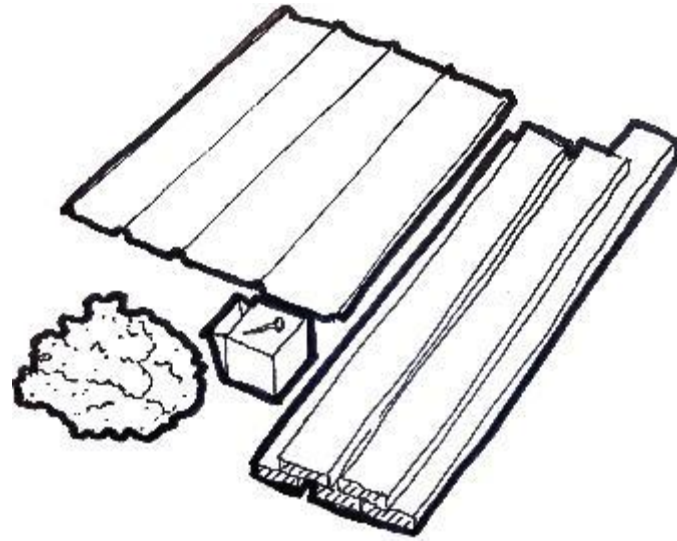
Performance benchmarked based  
an energy community - heat pump



### ENERGY COMMUNITY GROUND HEATING

Performance benchmarked based  
an energy community - ground heating



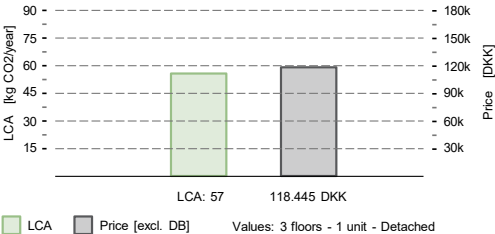


**Materials**



Materials

Starting point  
Untreated wood +  
Metal plates



Ma  
Facade cladding

Wood



Wood



Wood



Steel plate



Facade tiles



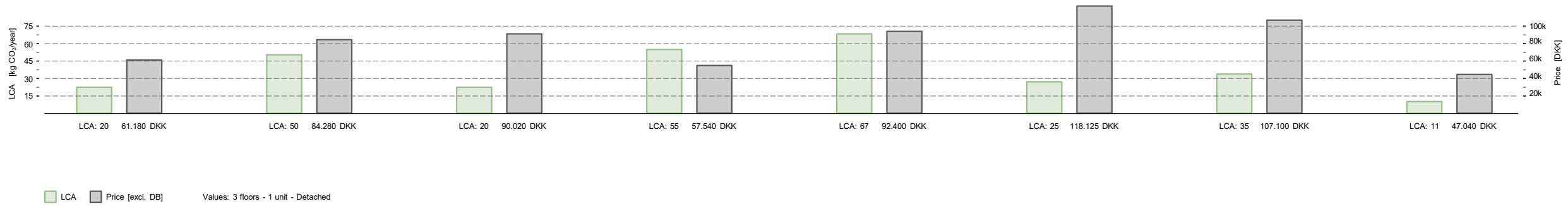
Slate



Fibercement



Plaster



Roof film



Metal plate



Metal plate



Roof tile



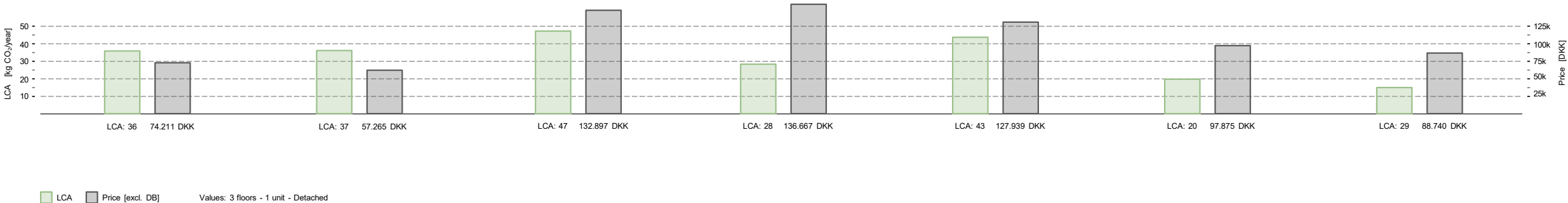
Wooden slats



Slate



Fibercement

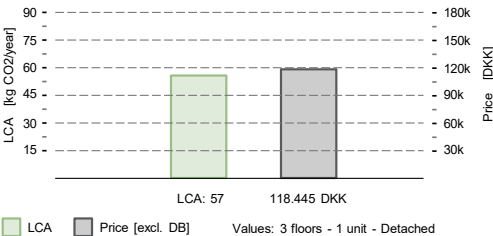




Materials

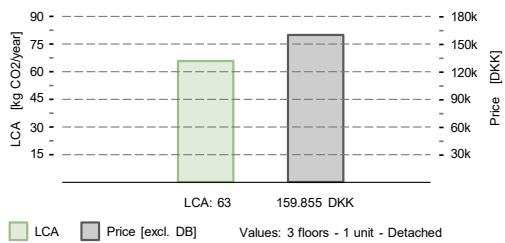
Untreated wood +

Metal plates



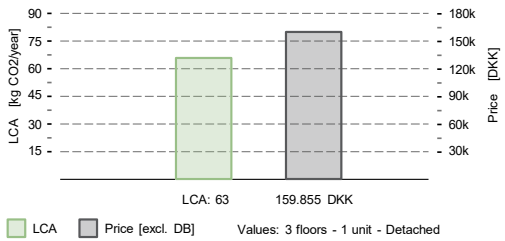
# Ma

## Untreated wood



# Ma

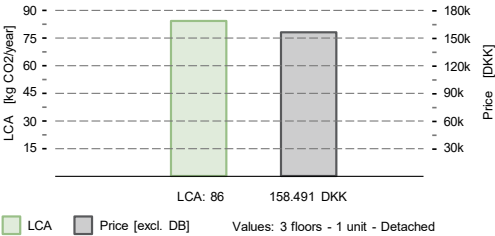
## Untreated wood





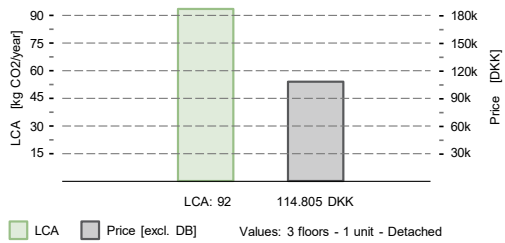
Materials

Black wood +  
Roofing paper



# Ma

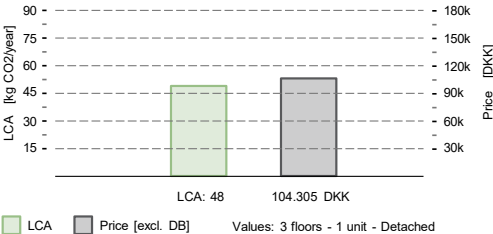
## Metal plates





# Materials

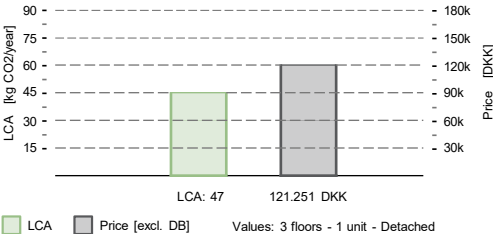
Plastered facade +  
Metal plates





# Materials

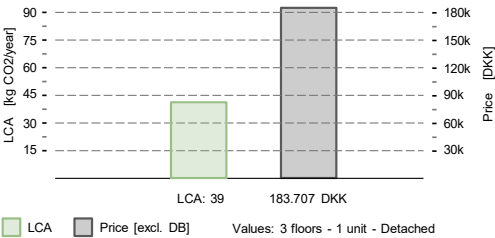
Plastered facade +  
Green roofing paper





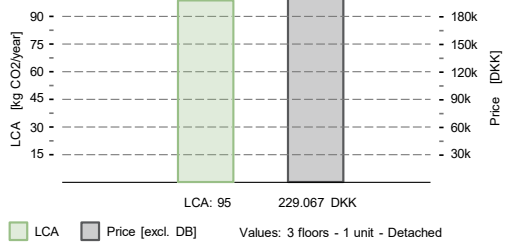
# Materials

Plastered facade +  
Roof tiles



# Ma

## Roof/facade tiles





## Materials Comparison



# Ma Comparison - LCA



Plastered  
facade  
Roof tiles

Plastered facade  
Metal plates

Untreated wood  
Metal plates

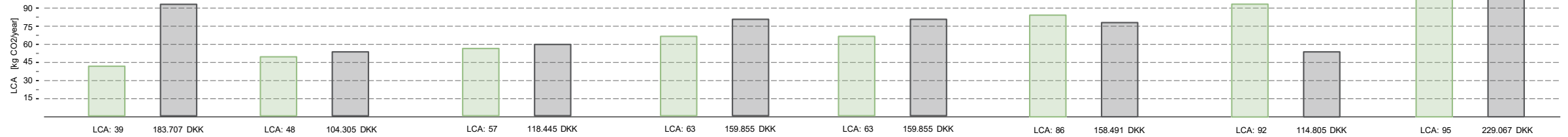
Untreated wood

Untreated wood

Black wood  
Roofing paper

Metal plates

Facade/roof  
tiles



↑  
STARTING POINT

# Ma Comparison - Price



Plastered  
facade  
Metal plates

Metal plates

Untreated wood  
Metal plates

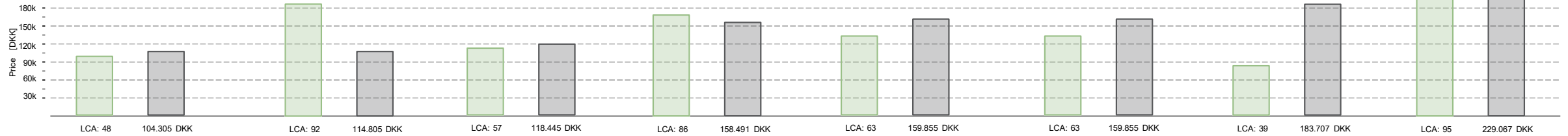
Black wood  
Roofing paper

Untreated wood

Untreated wood

Plastered facade  
Roof tiles

Facade/roof  
tiles



↑  
STARTING POINT

# Status and reductions

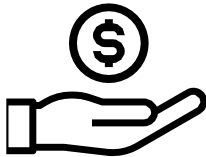
**How We Selected  
Value For Money**



**Lowest LCA**



**Value For Money  
(Selected)**



**Lowest Price**

# Original typology

## Starting point

The original typology is the 3 level detached house, this is the benchmark typology since it's the typology that is the hardest to get down in LCA and price, therefore this was the benchmark.

### Selected

LCA:  
3,8 kg CO<sup>2</sup> eq / m<sup>2</sup> / year  
Price:  
13.570 kr / m<sup>2</sup>

**Lowest LCA**  
LCA: 2,8 kg CO<sup>2</sup> eq / m<sup>2</sup> / year  
Price: 14.323 kr / m<sup>2</sup>

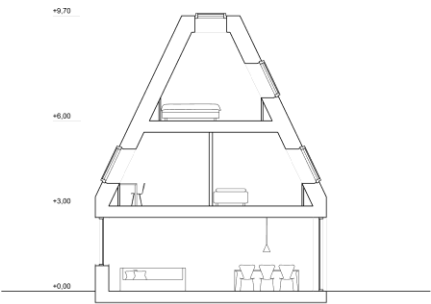
**Lowest Price**  
LCA: 4,3 kg CO<sup>2</sup> eq / m<sup>2</sup> / year  
Price: 11.486 kr / m<sup>2</sup>

Axonometric

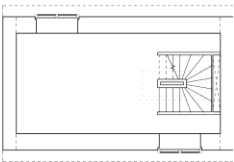
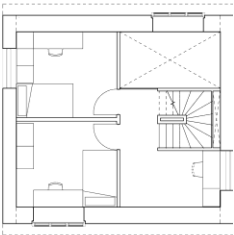


**Area:**  
147 m2 brutto  
1) 1 x 147 m2 homes

Section



Plans



# Modules

## Further reduction

|              | 2 levels<br>1 home (102 m2)                                                                                                                                                                       | 3 levels<br>1 home (147 m2)                                                                                                                                                                        | 3 levels<br>2 homes (62,4+102 m2)                                                                                                                                                                   | 4 levels<br>2 homes (62,4+147 m2)                                                                                                                                                                    | 4 levels<br>3 homes (2x62,4+102 m2)                                                                                                                                                                  | 5 levels<br>3 homes (2x62,4+147 m2)                                                                                                                                                                  |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Middle-house |  <p>LCA:<br/><b>3,2 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>11.651 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>10.104 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>11.871 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>10.921 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>3,0 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.012 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>11.258 kr</b> / m<sup>2</sup></p>   |
| Gable-house  |  <p>LCA:<br/><b>3,5 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>13.360 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>3,1 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>11.490 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>3,3 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>13.527 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>3,1 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.401 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>3,0 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>13.719 kr</b> / m<sup>2</sup></p>   |  <p>LCA:<br/><b>3,0 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.788 kr</b> / m<sup>2</sup></p>   |
| Corner-house |  <p>LCA:<br/><b>3,3 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.622 kr</b> / m<sup>2</sup></p> |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>10.818 kr</b> / m<sup>2</sup></p> |  <p>LCA:<br/><b>3,1 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.726 kr</b> / m<sup>2</sup></p> |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>11.664 kr</b> / m<sup>2</sup></p> |  <p>LCA:<br/><b>3,0 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.883 kr</b> / m<sup>2</sup></p> |  <p>LCA:<br/><b>2,8 kg</b> CO2 eq / m<sup>2</sup> / year</p> <p>Price:<br/><b>12.010 kr</b> / m<sup>2</sup></p> |
|              | + light foundation                                                                                                                                                                                |                                                                                                                                                                                                    | - heavy foundation<br>NOTE: not including outside accesstiar to top apartment                                                                                                                       |                                                                                                                                                                                                      | - heavy foundation<br>NOTE: not including lift or balcony acces                                                                                                                                      |                                                                                                                                                                                                      |

# Detached house

## 1 unit / 3 stories

The new 3 level detached house with the price reductions we made, during the process.

### Selected

LCA:  
**3,3 kg** CO<sup>2</sup> eq / m<sup>2</sup> / year  
Price:  
**12.922** kr / m<sup>2</sup>

**Lowest LCA**  
LCA: 2,9 kg CO<sub>2</sub> eq / m<sup>2</sup> / year  
Price: 13.651 kr / m<sup>2</sup>

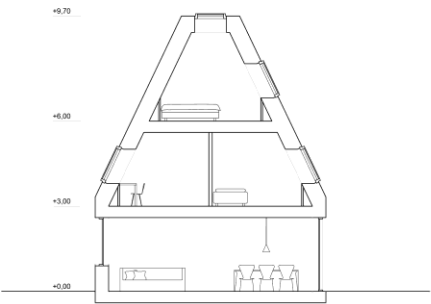
**Lowest Price**  
LCA: 3,7 kg CO<sub>2</sub> eq / m<sup>2</sup> / year  
Price: 12.197 kr / m<sup>2</sup>

Axonometric

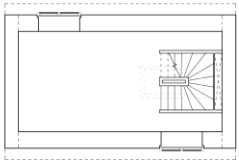
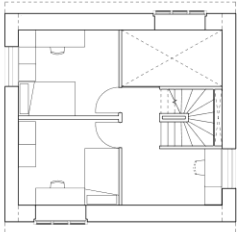
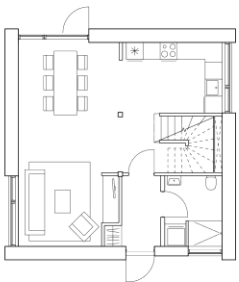


**Area:**  
147 m<sup>2</sup> brutto  
1) 1 x 147 m<sup>2</sup> homes

Section



Plans



# Double house

## 4 units / 3 stories

The Double House is made in 3 levels, and allows for the concept to have a small apartment in the bottom, that is useful for senior citizens or young professionals. This allows us to create a wider variety of housing options.

### Selected

LCA:

**3,3 kg** CO2 eq / m2 / year

Price:

**13.708** kr / m2

#### Lowest LCA

LCA: 3,0 kg CO2 eq / m2 / year

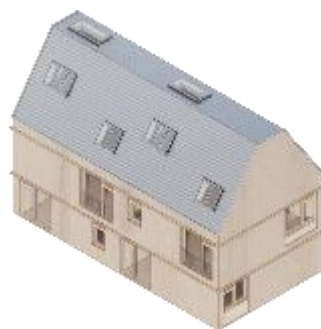
Price: 15.115 kr / m2

#### Lowest Price

LCA: 3,7 kg CO2 eq / m2 / year

Price: 13.128 kr / m2

Axonometric

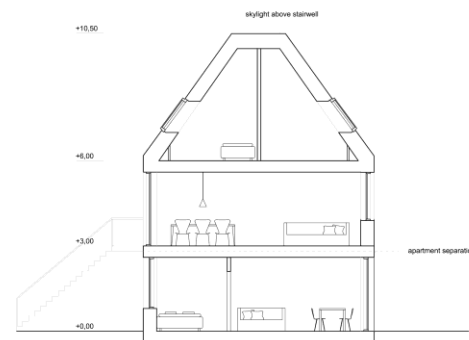


#### Area:

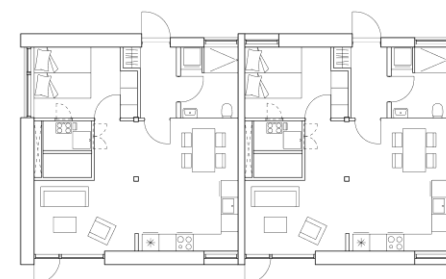
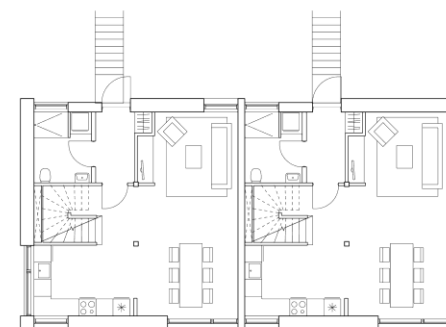
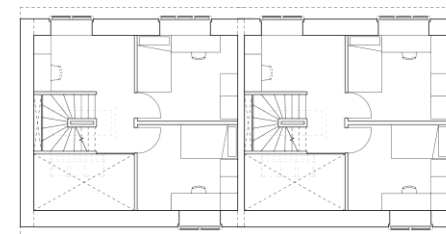
330 m2

- 1) 2 x 63 m2 homes
- 2) 2x 102 m2 homes

Section



Plans



# Rowhouse

## 4 units / 2 stories

A rowhouse with a low height and a covered entrance situation allows for garden houses and smaller rowhouses for younger families or elderly.

### Selected

LCA:

**3,35 kg** CO2 eq / m2 / year

Price:

**12.506** kr / m2

### Lowest LCA

LCA: 3,0 kg CO2 eq / m2 / year

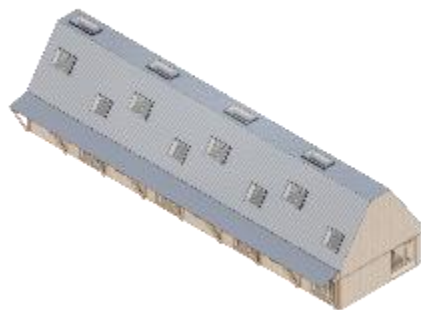
Price: 13.981 kr / m2

### Lowest Price

LCA: 3,75 kg CO2 eq / m2 / year

Price: 11.841 kr / m2

Axonometric

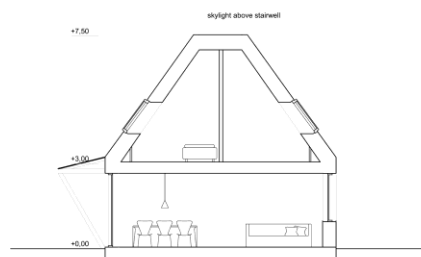


### Area:

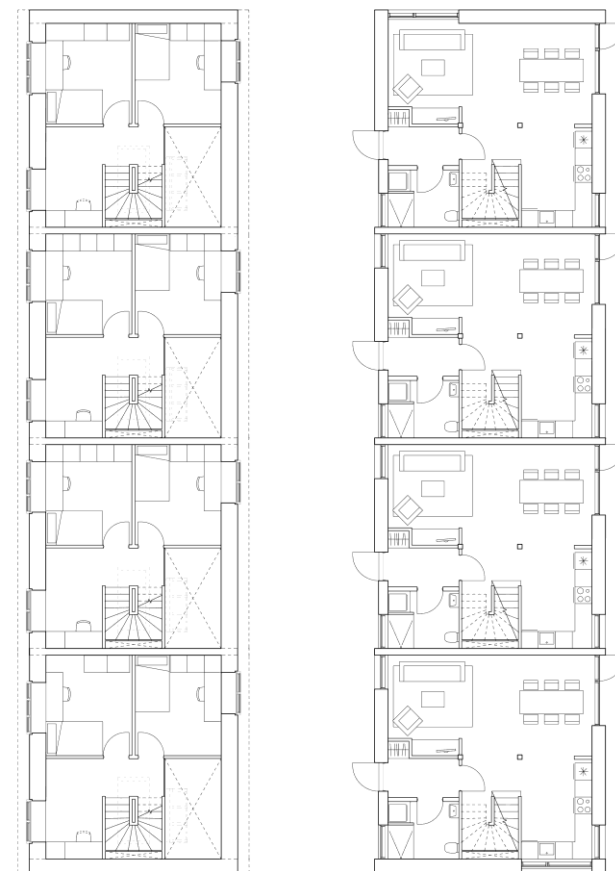
408 m2

1) 4 x 102 m2 homes

Section



Plans



# Short linear block

## 12 units / 5 stories

The short linear block is made in 5 storeys, is only aprox 35 meters long and would be ideal as a fill in project in urban contexts. It consists of 2 layers of smaller appartments and a 3 storey typology for co-housing or penthouse.

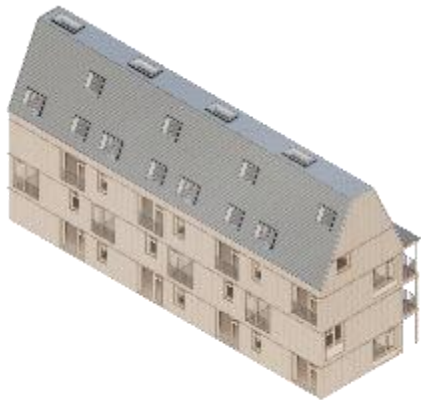
### Selected

LCA:  
**2,95 kg** CO2 eq / m2 / year  
Price:  
**12.470** kr / m2

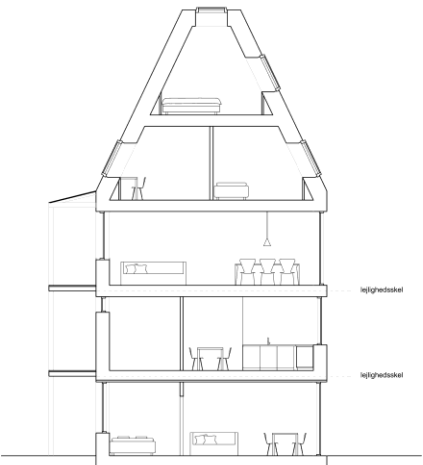
**Lowest LCA**  
LCA: 2,7 kg CO2 eq / m2 / year  
Price: 13.567 kr / m2

**Lowest Price**  
LCA: 3,5 kg CO2 eq / m2 / year  
Price: 11.995 kr / m2

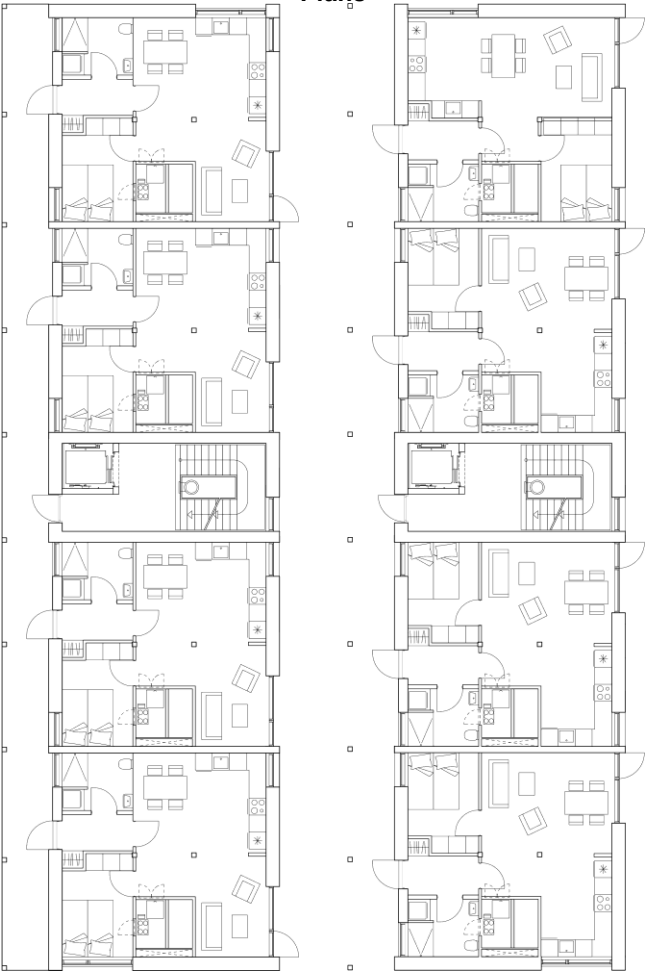
Axonometric



Section



Plans



**Area:**  
1211,7 m2

- 1) 8 x 63 m2 homes
- 2) 4 x 147 m2 homes

# Long linear block

## 24 units / 5 stories

The long linear block is made in 5 storeys and is optimized in both price and LCA due to minimizing shafts, lifts and gables. It consists of 2 layers of smaller appartments and a 3 storey typology for co-housing or penthouse.

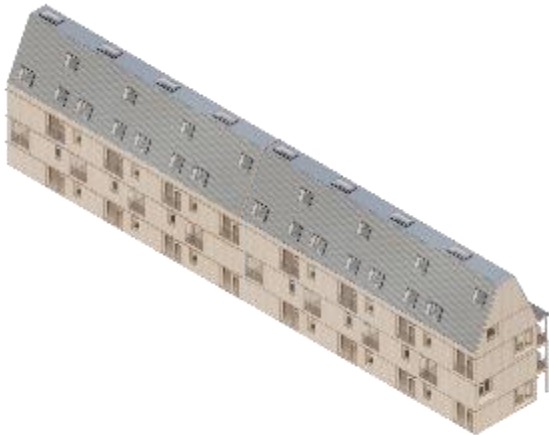
### Selected

LCA:  
**2,8 kg** CO2 eq / m2 / year  
Price:  
**11.732** kr / m2

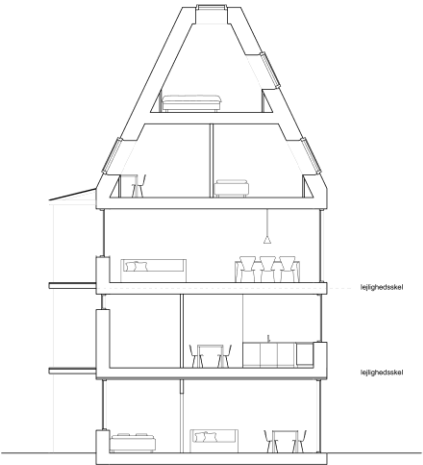
**Lowest LCA**  
LCA: 2,5 kg CO2 eq / m2 / year  
Price: 12.866 kr / m2

**Lowest Price**  
LCA: 3,2 kg CO2 eq / m2 / year  
Price: 11.307 kr / m2

Axonometric



Section



Plans



**Area:**  
2464 m2 brutto  
1) 16 x 63 m2 homes  
2) 8 x 147 m2 homes

## Courtyard block 48 units / 4 stories

The courtyard block is the most urban typology, that fits into most urban contexts, making a clear courtyard and streetscape motive. It consists like the linear block of two layers of smaller appartments and a 2 storey typology on top for larger appartments. The social aspect of this typology is high.

### Selected

LCA:

**2,9 kg** CO2 eq / m2 / year

Price:

**12.533** kr / m2

### Lowest LCA

LCA: 2,7 kg CO2 eq / m2 / year

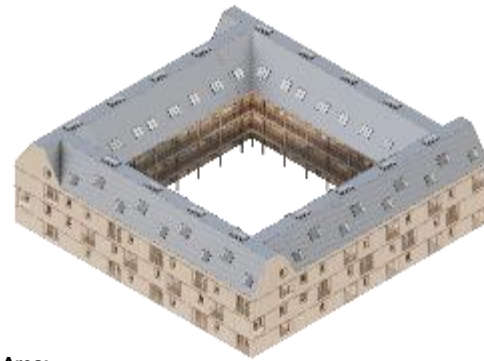
Price: 13.726 kr / m2

### Lowest Price

LCA: 3,5 kg CO2 eq / m2 / year

Price: 11.863 kr / m2

Axonometric



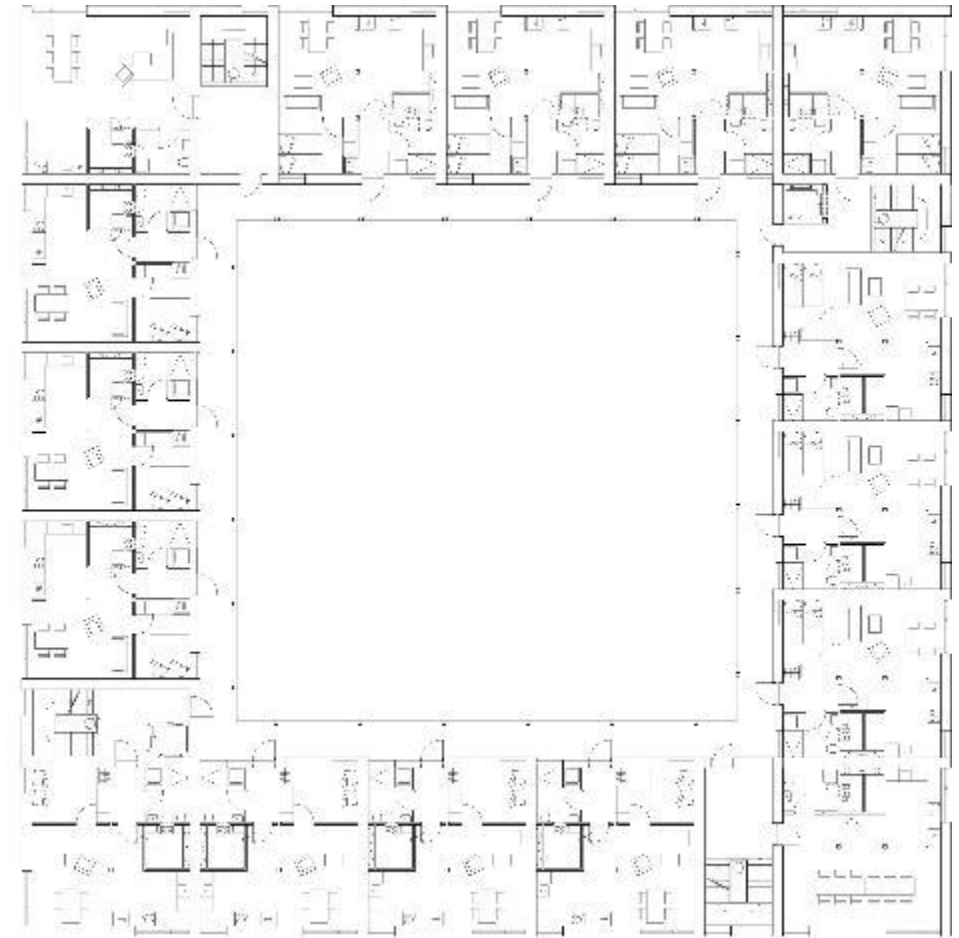
Area:  
4280 m2 brutto

- 1) 32 x 63 m2 homes
- 2) 16 x 102 m2 homes

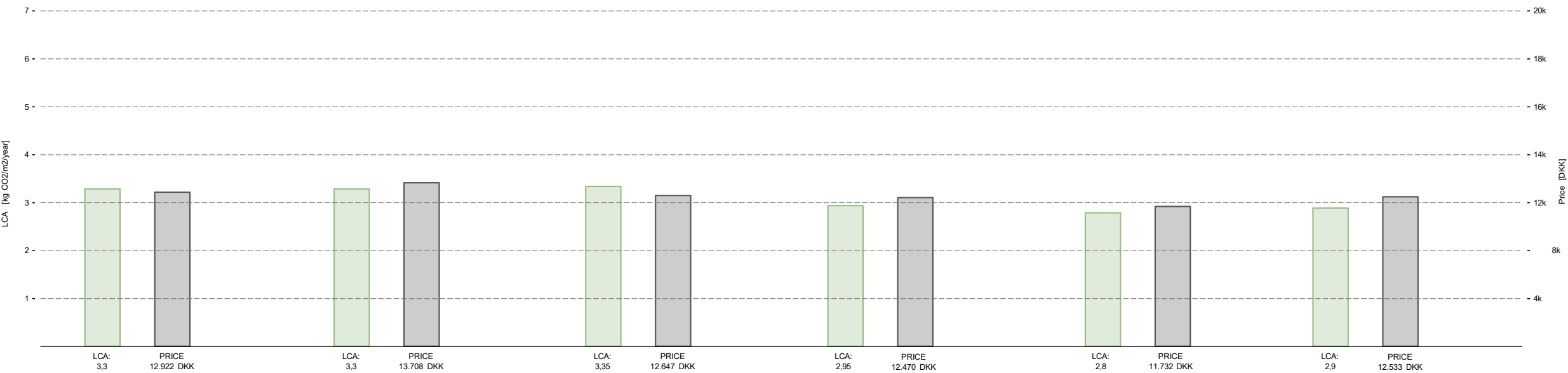
Section



Plans



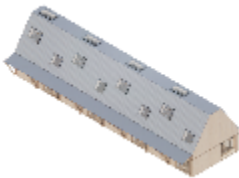
# Typologies comparison



**Selected**  
LCA:  
**3,3 kg** CO2 eq / m2 / year  
Price:  
**12.922** kr / m2



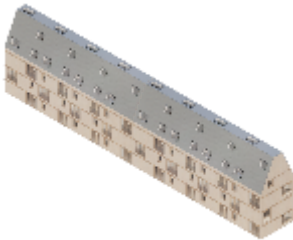
**Selected**  
LCA:  
**3,3 kg** CO2 eq / m2 / year  
Price:  
**13.708** kr / m2



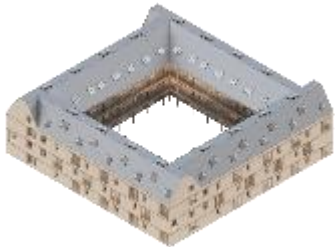
**Selected**  
LCA:  
**3,35 kg** CO2 eq / m2 / year  
Price:  
**12.647** kr / m2



**Selected**  
LCA:  
**2,95 kg** CO2 eq / m2 / year  
Price:  
**12.470** kr / m2

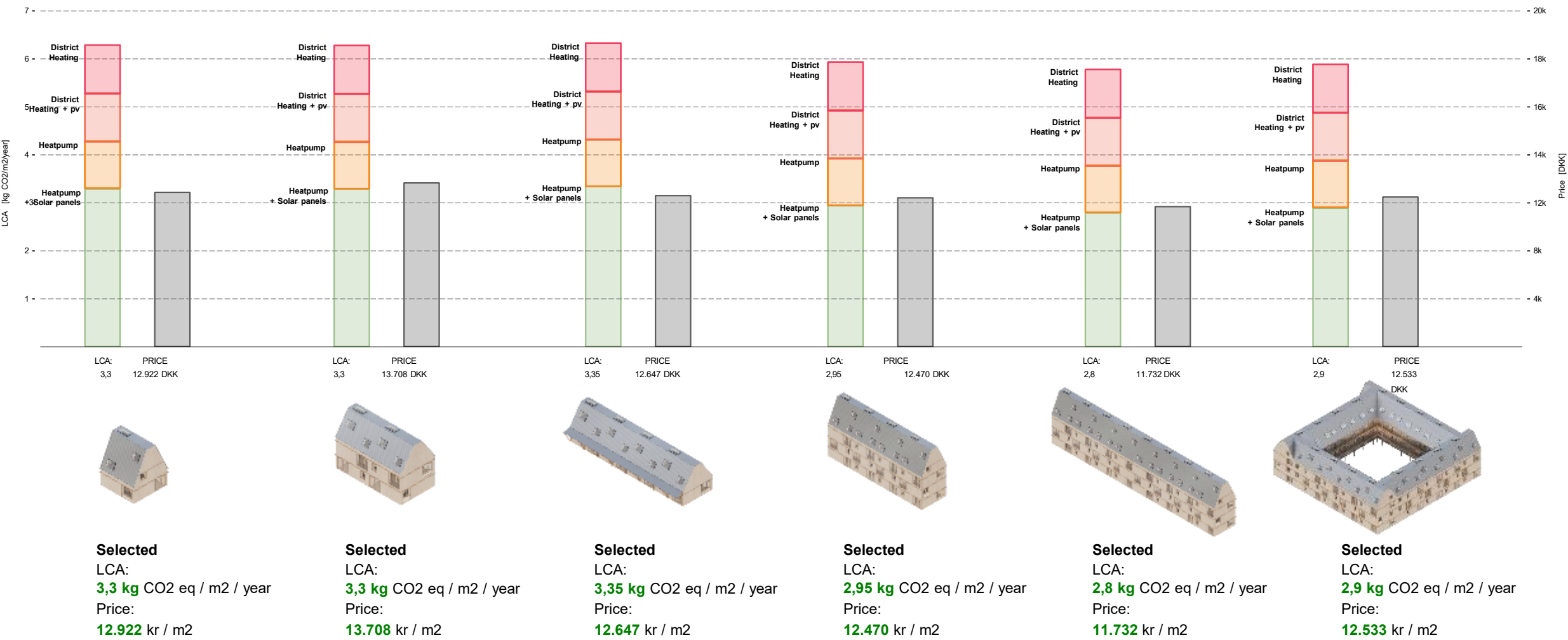


**Selected**  
LCA:  
**2,8 kg** CO2 eq / m2 / year  
Price:  
**11.732** kr / m2



**Selected**  
LCA:  
**2,9 kg** CO2 eq / m2 / year  
Price:  
**12.533** kr / m2

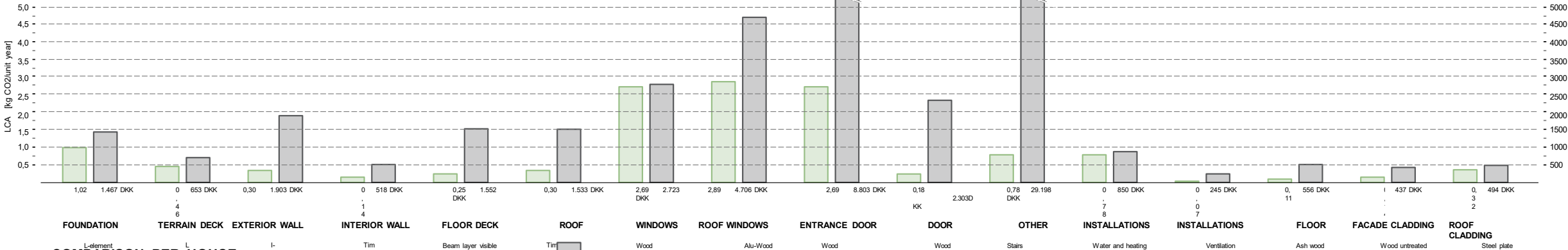
# Typologies comparison



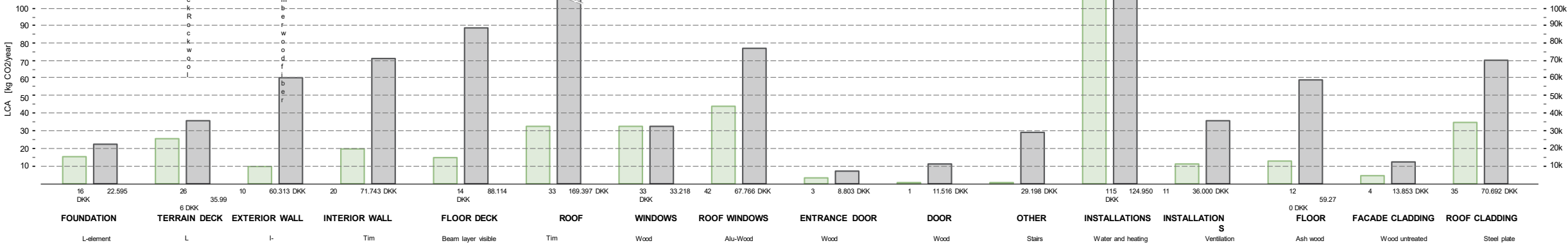
Comparison  
Selected solution



COMPARISON PER UNIT  
1 UNIT OF ELEMENT



COMPARISON PER HOUSE  
3 FLOOR - 1 UNIT - MIDDLE ELEMENT



BUILD-UP



COMPONENTS



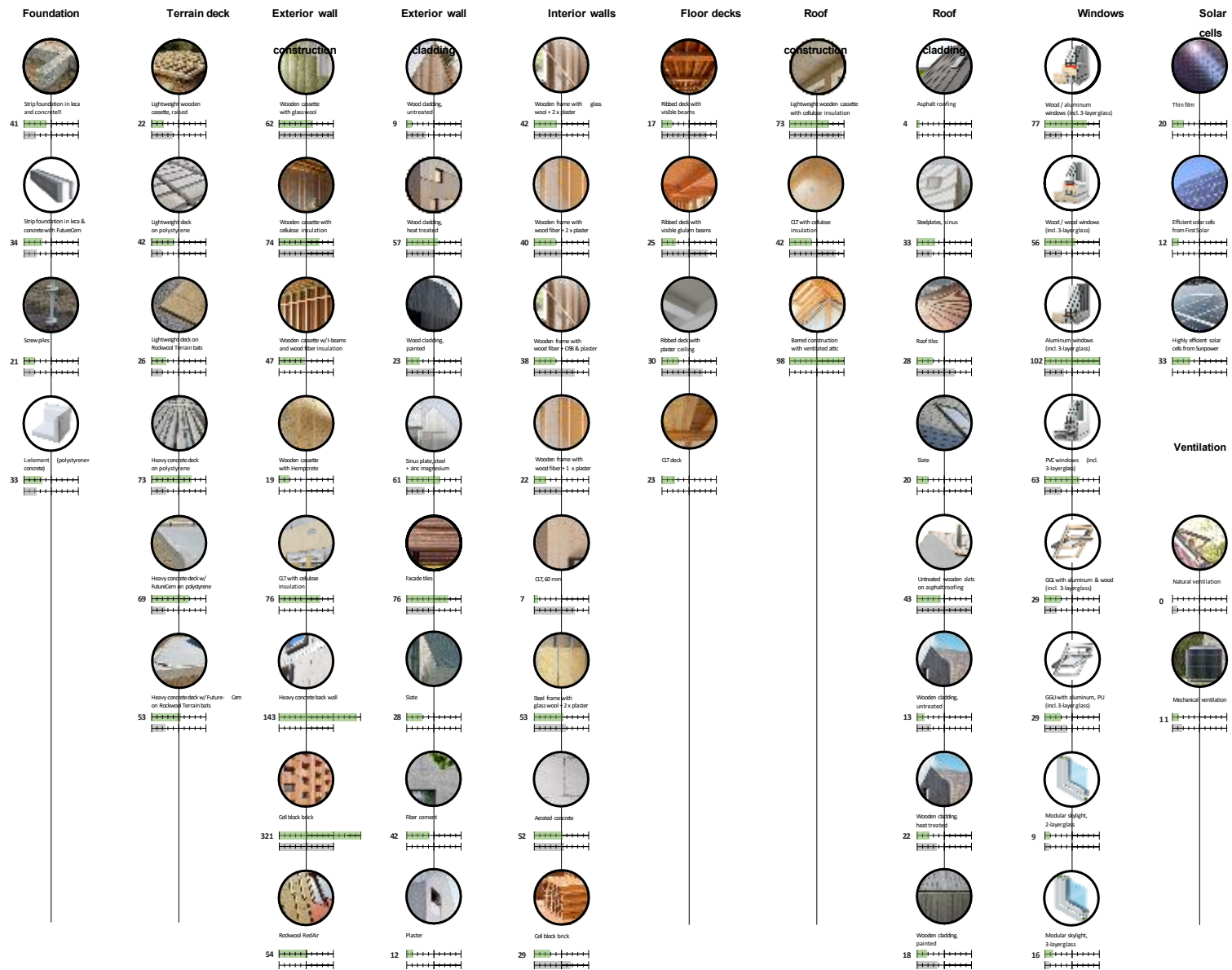
MATERIALS

LCA Price [excl. DB]

Values: 3 floors - 1 unit - Middle element

# Tool and ongoing process

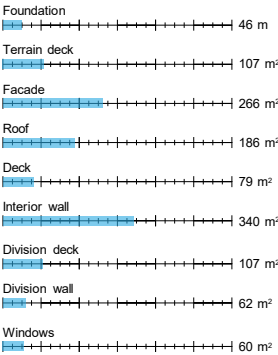
LCA & Price tool  
Comparison tool



LCA (Kg CO2/year/unit)  
Price (DKK/unit)

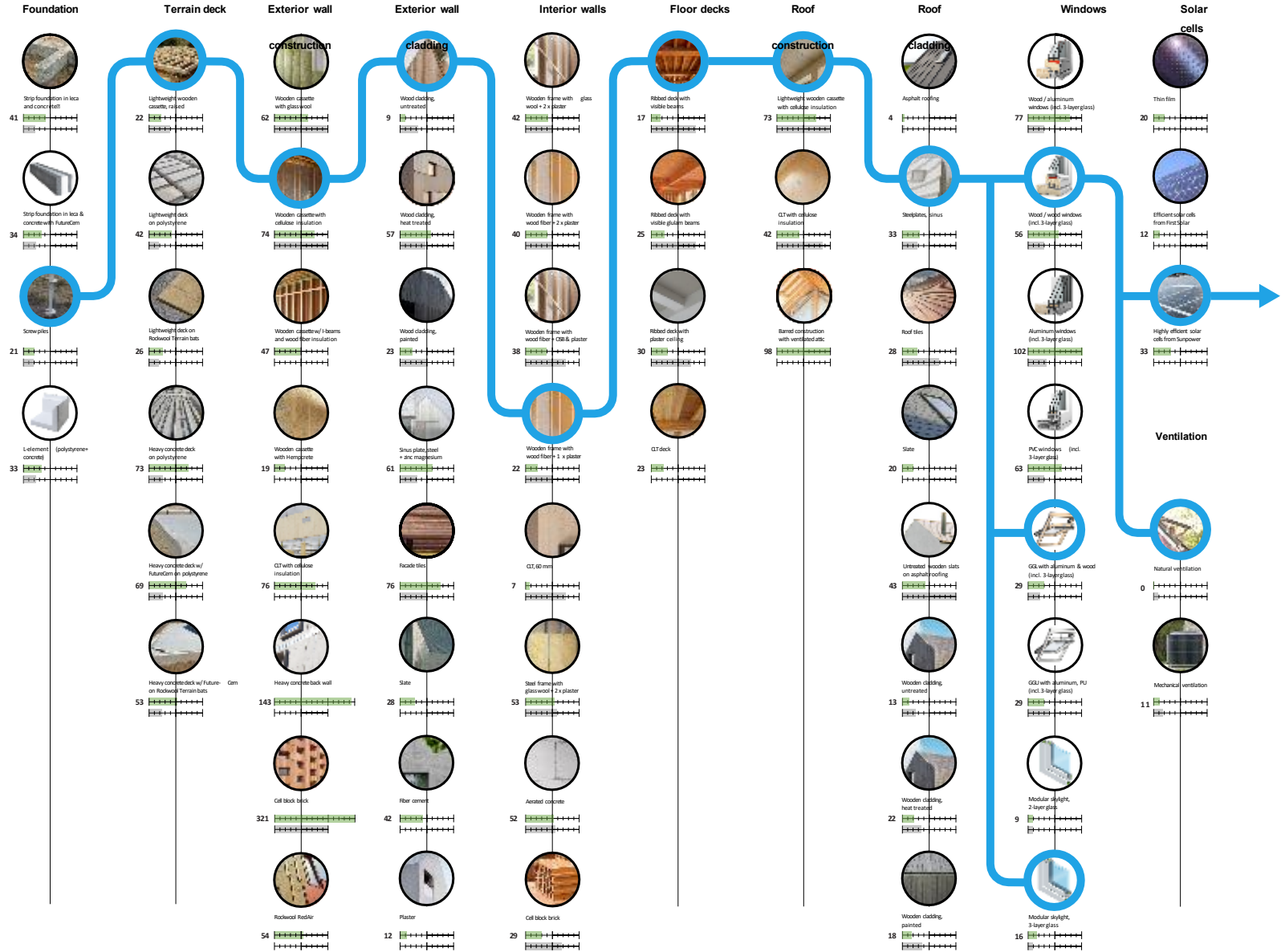
LCA & Price tool

Double house



LCA (Kg CO2/year/unit)

Price (DKK/unit)



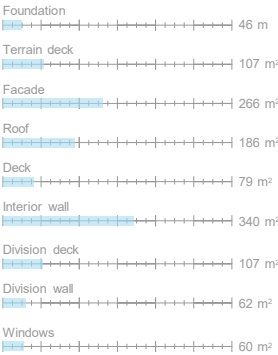
LCA: 3,10 kgCO2/m<sup>2</sup> year

Price: 11385,00 DKK/m<sup>2</sup>

LCA & Price tool

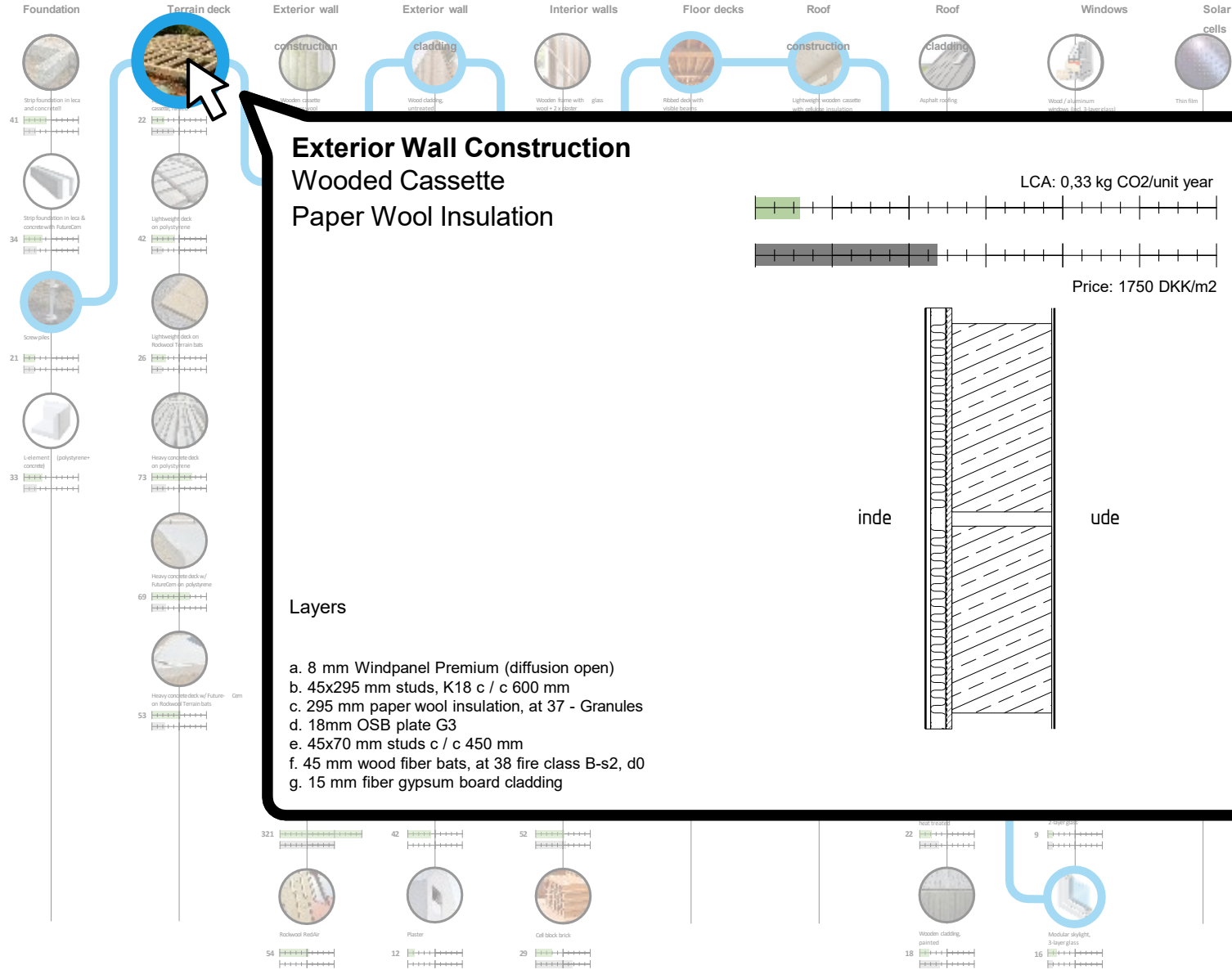
Double house

2 units / 3 floors



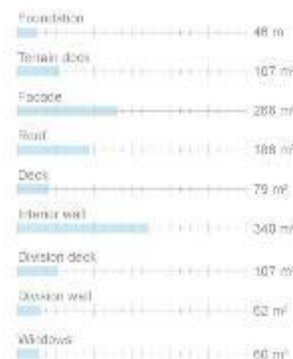
LCA (Kg CO2/year/unit)

Price (DKK/unit)

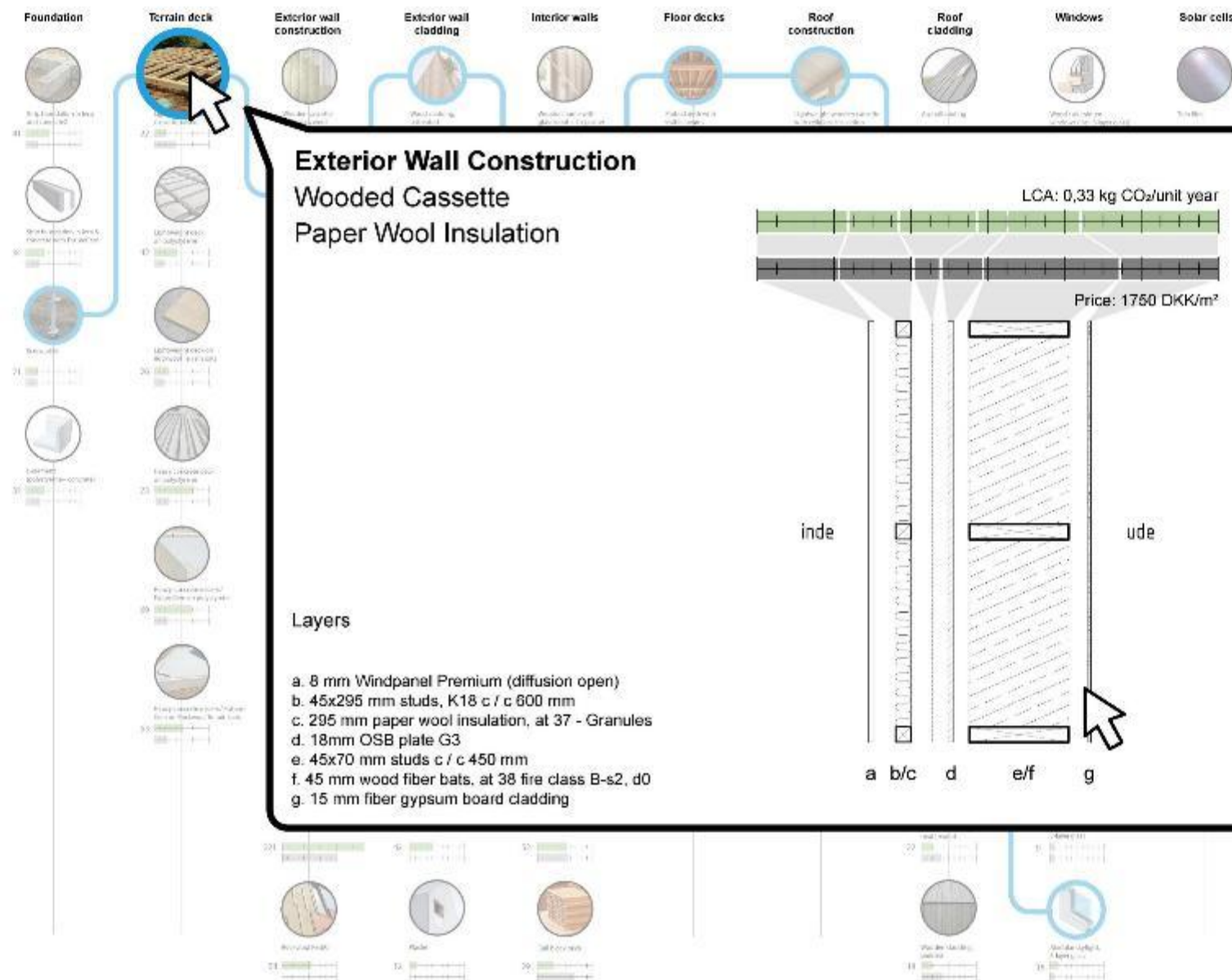


# LCA & Price tool

Double house

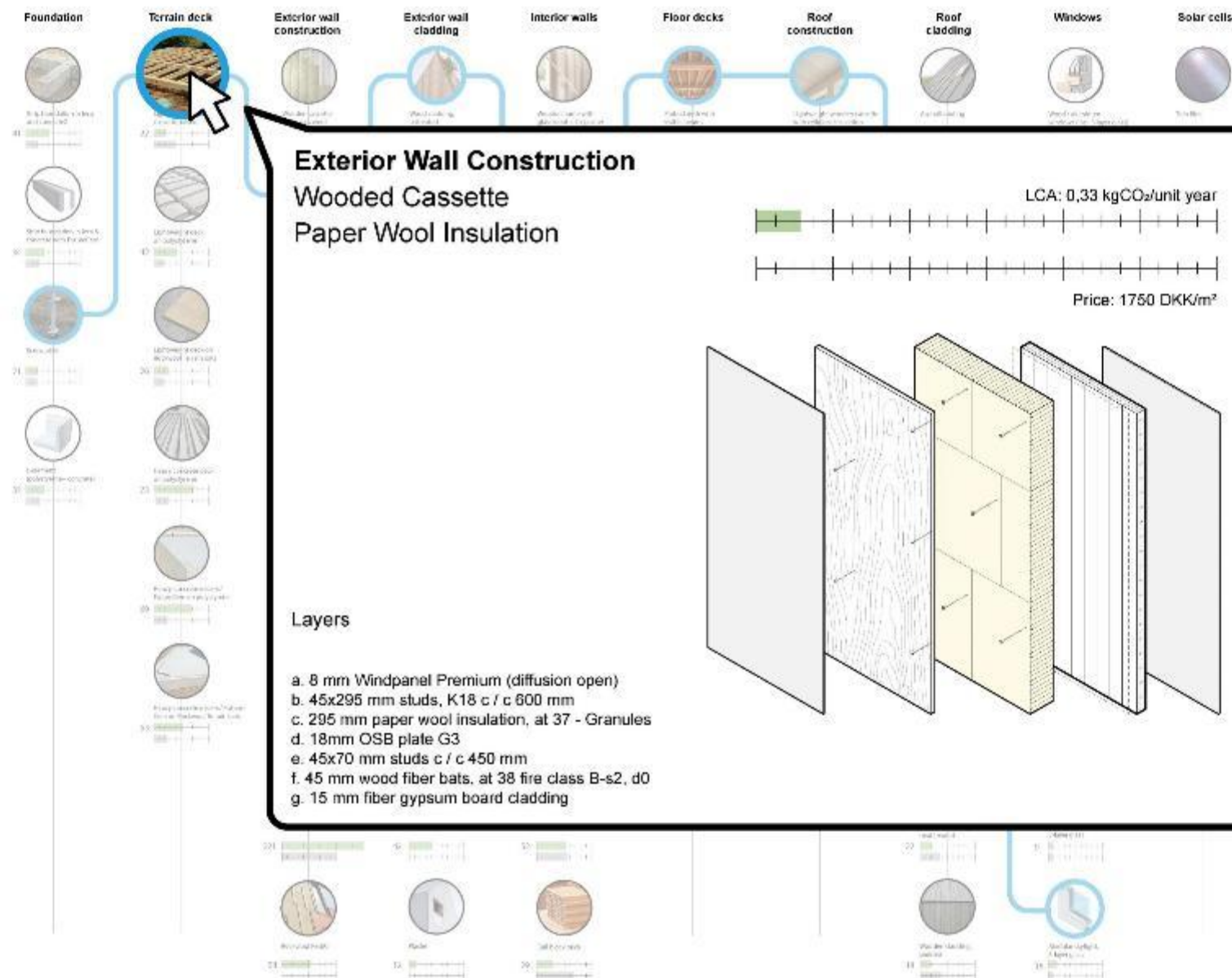
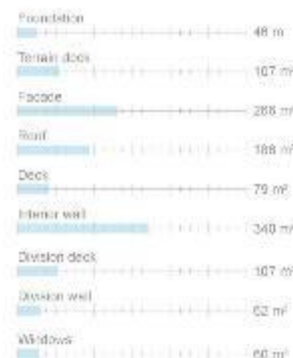


LCA (Kg CO<sub>2</sub>eq/m²)  
Price (DKK/m²)



# LCA & Price tool

Double house



# Fire restrictions

A multi-storey residential building placed in fire class 2 must be constructed in accordance with the Building Regulations' guidelines for Chapter 5 - Fire and the pre-accepted solutions specified in the accompanying Appendix 2 "Pre-accepted solutions - Multi-storey residential construction".

This includes e.g. does not deviate from the following:

In buildings with a floor on the upper floor more than 5.1 m above ground, where the load-bearing structures are not made of materials that are at least class A-s1, d0 (non-combustible material), insulating materials that are inferior to material class must not be used. B-s1, d0 (class 1 material) in connection with these load-bearing building components

In fire cells (dwellings) on two floors, in order to prevent people being trapped in the fire cell, it will be necessary for there to be exits from both floors.

It can be seen from the above that placement in fire class 2 e.g. makes the use of bio-based insulation material inferior to B-s1, d2 impossible in buildings with load-bearing wooden structures.

Furthermore, it is not possible to furnish dwellings on two floors, of which only the lower floor has access to an escape route.

If it is desired to deviate from the pre-accepted solutions, the building must be placed in fire class 3 or 4. This allows the pre-accepted solutions to be deviated from if the safety level can be documented using comparative analyzes or fire-technical reasoned assessments.



## Fire input 2 levels / rowhouse

Enfamilieshus indrettet efter Bilag 1a uden afvigelser => BK1, under forudsætning af at rækkehuse opdeles i brandmæssigt fritliggende bygningsafsnit på maksimalt 600 m<sup>2</sup> - det vil sige 5 rækkehuse med denne typologi kan sammenbygges i BK1. Sammenbygges flere skal byggeriet henføres til BK2. Afviges der fra Bilag 1a er der tale om BK3. A = 118 m<sup>2</sup> Gulv i øverste etage < 5,1 m over terræn

**Bærende konstruktioner:** R 30 OBS! Skærpede krav til bygningsdele, der støtter eller stabilisere brandcelleadskillelser og brandsektioner!

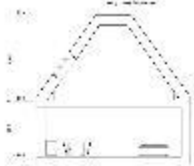
**Adskillende bygningsdele:** Brandcelleadskillelser (mellem boliger): EI60 Brandsektionsadskillelser (til opdeling af bygningsafsnit større end 1200 m<sup>2</sup>): EI60 / A2-s1,d0 Det ses at den brandcelleadskillende bygningsdel kan indeholde træ, mens det ikke er tilfældet for den brandsektionsadskillende bygningsdel.

Udvendige overflader: K1 10

/ D-s2,d2 - Alternativt materialeklasse D-s2,d2. Hvis der anvendes regnskærm skal beklædning være K1 10 / B-s1,d0 mens regnskærm skal være D-s2,d2 - Husk brandstop! Tag som BROOF(t2).

**Indvendige overflader:**

K1 10 / D-s2,d2 Isolering: D-s2,d2 - OBS på adskillende bygningsdele.



## Fire input 3 levels / rowhouse

BK3: Enfamilieshus indrettet efter Bilag 1a men med afvigelser => BK3. A < 150 m<sup>2</sup> Gulv i øverste etage > 5,1 m over terræn

**Bærende konstruktioner:**

R 30 OBS! Skærpede krav til bygningsdele, der støtter eller stabilisere brandcelleadskillelser og brandsektioner!

**Adskillende bygningsdele:**

Brandcelleadskillelser (mellem boliger): EI60

Brandsektionsadskillelser (til opdeling af bygningsafsnit større end 1200 m<sup>2</sup>): EI60 / A2-s1,d0

Det ses at den brandcelleadskillende bygningsdel kan indeholde træ, mens det ikke er tilfældet for den brandsektionsadskillende bygningsdel.

**Udvendige overflader:**

K1 10 / D-s2,d2 - Alternativt materialeklasse D-s2,d2.

Hvis der anvendes regnskærm skal beklædning være K1 10 / B-s1,d0 mens regnskærm skal være D-s2,d2 - Husk brandstop! Tag som BROOF(t2).

**Indvendige overflader:** K1 10 / D-s2,d2

**Isolering:** B-s2,d0 - Det vil sige kan være brandimpregneret papirgranulat eller tilsvarende - AFVIGELSE.

**Brandinput - BK1-2:**

Enfamilieshus indrettet efter Bilag 1a uden afvigelser => BK1, under forudsætning af at rækkehuse opdeles i brandmæssigt fritliggende bygningsafsnit på maksimalt 600 m<sup>2</sup> - det vil sige 3 rækkehuse med denne typologi kan sammenbygges i BK1.

Sammenbygges flere skal byggeriet henføres til BK2.

**Isolering:**

B-s1,d0 - Brandimpregneret papirgranulat eller tilsvarende kan ikke anvendes, idet her ikke kan opnås tillægsklasse s1.

I øvrigt krav som angivet i ovenstående.



## Fire input 3 levels / apartment building

Etagebolig indrettet efter Bilag 2 uden afvigelser => BK2 Afviges der fra Bilag 2 er der tale om BK3. OBS! Med nuværende indretning (bolig i to etage, kun flugtvej fra nederste etage) afviges der fra Bilag 2 => BK3. Gulv i øverste etage > 5,1 m over terræn

**Bærende konstruktioner:** Øverste etage: R 30 Øvrige: R

60 / D-s2,d2, hvor de bærende konstruktioners samlede brandeksponerede overflade, indenfor de første 60 minutter af standardbrandforløbet udgør højst 20 % af rummets samlede væg- og loftoverflader. Hvor den bærende

konstruktion samlede brandeksponerede overflade overstiger 20% inddækkes den del, der over stiger 20% på en af følgende måder:

- Brandbeskyttende beklædning udført af materiale klasse A2-s1,d0, hvor det dokumenteres ifølge DS/EN 1995-1-2, at der ikke sker indbrænding af træet i de første 60 minutter af en standardbrandpåvirkning
- Brandbeskyttelsessystem klasse K2 60 / A2 Trapper: Materiale klasse D-s2,d2

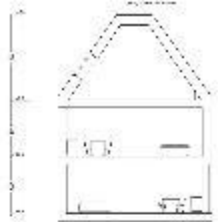
Kravet er en vurdering ift. kapitel 3, som angiver at det kun er trapper i bygninger med gulv i øverste etage < 5,1 m over terræn som kan udføres i materiale klasse D-s2,d2 - her er der i stedet set på gulv i øverste boligenhed - OK med vurdering, da der er tale om BK3-sag.

**Adskillende bygningsdele:** Brandcelleadskillelser (mellem boliger): EI60 Brandsektionsadskillelser (til opdeling af bygningsafsnit større end 600 m<sup>2</sup>): Bygningsdel klasse EI 60 / D-s2,d2 udført med mindst beklædning klasse K2 60 / A2-s1,d0 eller Bygningsdel klasse EI 60

/ D-s2,d2 udført med mindst brandbeskyttende beklædning udført af materialeklasse A2-s1,d0, og det dokumenteres, jf. DS/EN 1995-1-2, at der ikke sker indebrænding af træet i de første 60 minutter af en standardbrandpåvirkning. Udvendige overflader: K1 10 / B-s1,d0 Evt. regnskærm skal opfylde krav til B-s2,d0. Mindre partier med et samlet areal på højst 20 % af ydervæggens areal og jævnt fordelt, kan udføres med regnskærm som materiale klasse D-s2,d2. Partiernes placering, så risikoen for brandspredning fra en brandmæssig enhed til en anden enhed minimeres. Tag som BROOF(t2).

**Indvendige overflader:** Vægge: K1 10 / D-s2,d2 Loft: K1 10

/ B-s1,d0 Isolering: B-s1,d0





## Fire input 4 levels / apartment building

Etagebolig indrettet efter Bilag 2 uden afvigelser =>  
BK2 Afviges der fra Bilag 2 er der tale om BK3.  
OBS! Med nuværende indretning (bolig i tre etager (1.+2.+3.)), kun flugtvej fra nederste etage) afviges der fra Bilag 2 => BK3. Gulv i øverste etage < 12 m over terræn

### Bærende konstruktioner:

Øverste etage: R 30  
Øvrige: R 60 / D-s2,d2, hvor de bærende konstruktioners samlede brandeksponerede overflade, indenfor de første 60 minutter af standardbrandforløbet udgør højst 20 % af rummets samlede væg- og loftoverflader.

Hvor den bærende konstruktions samlede brandeksponerede overflade overstiger 20% inddækkes den del, der over stiger 20% på en af følgende måder:

- Brandbeskyttende beklædning udført af materiale klasse A2-s1,d0, hvor det dokumenteres ifølge DS/EN 1995-1-2, at der ikke sker indbrænding af træet i de første 60 minutter af en standardbrandpåvirkningen

- Brandbeskyttelsessystem klasse K2 60 /A2-s1,d0

Adskillende bygningsdele:

Brandcelleadskillelser (mellem boliger): EI60

Brandsektionsadskillelser (vandret + lodret hvis nødvendigt aht.

til opdeling af bygningsafsnit større end 600 m2):

Bygningsdel klasse EI 60 / D-s2,d2 udført

med mindst beklædning klasse K2 60 / A2-s1,d0

eller

Bygningsdel klasse EI 60 / D-s2,d2 udført

med mindst brandbeskyttende beklædning udført af materialeklasse

A2-s1,d0, og det

dokumenteres, jf. DS/EN 1995-1-2, at der ikke sker indebrænding af træet i de første

60 minutter af en standardbrandpåvirkning.

Udvendige overflader:

K1 10 / B-s1,d0

Evt. regnskærm skal opfylde krav til B-s2,d0.

Mindre partier med et samlet areal på højst 20 % af ydervæggens areal og jævnt fordelt, kan udføres med regnskærm som materiale klasse D-s2,d2. Partierne placeres, så risikoen for brandspredning fra en brandmæssig enhed til en anden enhed minimeres.

Tag som BROOF(t2).

Indvendige overflader:

Vægge: K1 10 / D-s2,d2

Loft: K1 10 / B-s1,d0

Isolering:

B-s1,d0

Trapper:

Materiale klasse D-s2,d2



## Fire input 4 levels / apartment building

Etagebolig indrettet efter Bilag 2 uden afvigelser =>  
BK2 Afviges der fra Bilag 2 er der tale om BK3.  
OBS! Med nuværende indretning (bolig i to etager (2.+3.)), kun flugtvej fra nederste etage) afviges der fra Bilag 2 => BK3. Gulv i øverste etage < 12 m over terræn

### Bærende konstruktioner:

Øverste etage: R 30

Øvrige: R 60 / D-s2,d2, hvor de bærende konstruktioners samlede brandeksponerede overflade, indenfor de første 60 minutter af standardbrandforløbet udgør højst 20 % af rummets samlede væg- og loftoverflader.

Hvor den bærende konstruktions samlede brandeksponerede overflade overstiger 20% inddækkes den del, der over stiger 20% på en af følgende måder:

- Brandbeskyttende beklædning udført af materiale klasse A2-s1,d0, hvor det dokumenteres ifølge DS/EN 1995-1-2, at der ikke sker indbrænding af træet i de første 60 minutter af en standardbrandpåvirkningen

- Brandbeskyttelsessystem klasse K2 60 /A2-s1,d0

Adskillende bygningsdele:

Brandcelleadskillelser (mellem boliger): EI60

Brandsektionsadskillelser (vandret + lodret hvis nødvendigt aht.

til opdeling af bygningsafsnit større end 600 m2):

Bygningsdel klasse EI 60 / D-s2,d2 udført

med mindst beklædning klasse K2 60 / A2-s1,d0

eller

Bygningsdel klasse EI 60 / D-s2,d2 udført

med mindst brandbeskyttende beklædning udført af materialeklasse

A2-s1,d0, og det

dokumenteres, jf. DS/EN 1995-1-2, at der ikke sker indebrænding af træet i de første

60 minutter af en standardbrandpåvirkning.

Udvendige overflader:

K1 10 / B-s1,d0

Evt. regnskærm skal opfylde krav til B-s2,d0.

Mindre partier med et samlet areal på højst 20 % af ydervæggens areal og jævnt fordelt, kan udføres med regnskærm som materiale klasse D-s2,d2. Partierne placeres, så risikoen for brandspredning fra en brandmæssig enhed til en anden enhed minimeres.

Tag som BROOF(t2).

Indvendige overflader:

Vægge: K1 10 / D-s2,d2

Loft: K1 10 / B-s1,d0

Isolering:

B-s1,d0

Altangange:

Bæreevne R 60 / D-s2,d2 - søjler kan evt. stå uinddækket og dimensioneres for indbrænding.

Dækket etableres med brandmodstandsevne EI60.

Gulve som gulvbelægning Dfl og loft som beklædning K1 10 / B-s1,d0

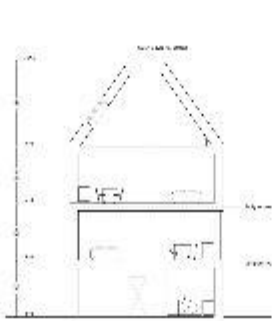
I de ender af altangangen, som ikke giver adgang til flugtvejstrappe, skal der være mulighed for redning. Altangange betyder at boliger kan indrettes uden redningsåbninger.

Flugtvejstrappe:

Placeres i selvstændig brandsektion og vejrligssikres (lukkes)

Trapper som bygningsdel R 30 / A2-s1,d0 eller R 30 / D-s2,d2 med

beklædning som mindst klasse K2 30 / A2-s1,d0 på undersiden og langs siderne



## Fire input 4 levels / apartment building

Etagebolig indrettet efter Bilag 2 uden afvigelser =>  
BK2 Afviges der fra Bilag 2 er der tale om BK3.  
OBS! Med nuværende indretning (bolig i tre etager (2.+3.+4.)), kun flugtvej fra nederste etage) afviges der fra Bilag 2 => BK3. OBS! Hvis øverste lejlighed er større end 150 m2 skal det sikres at ganglængden fra ethvert sted i boligen til udgang er højst 30 m. Gulv i øverste etage < 12 m over terræn

### Bærende konstruktioner:

Øverste etage: R 30

Øvrige: R 60 / D-s2,d2, hvor de bærende konstruktioners samlede brandeksponerede overflade, indenfor de første 60 minutter af standardbrandforløbet udgør højst 20 % af rummets samlede væg- og loftoverflader.

Hvor den bærende konstruktions samlede brandeksponerede overflade overstiger 20% inddækkes den del, der over stiger 20% på en af følgende måder:

- Brandbeskyttende beklædning udført af materiale klasse A2-s1,d0, hvor det dokumenteres ifølge DS/EN 1995-1-2, at der ikke sker indbrænding af træet i de første 60 minutter af en standardbrandpåvirkningen

- Brandbeskyttelsessystem klasse K2 60 /A2-s1,d0

### Adskillende bygningsdele:

Brandcelleadskillelser (mellem boliger): EI60

Brandsektionsadskillelser (vandret + lodret hvis nødvendigt aht. til opdeling af bygningsafsnit større end 600 m2): Bygningsdel klasse

EI 60 / D-s2,d2 udført med mindst beklædning klasse K2 60 / A2-

s1,d0 eller Bygningsdel klasse EI 60 / D-s2,d2 udført

med mindst brandbeskyttende beklædning udført af materialeklasse

A2-s1,d0, og det dokumenteres, jf. DS/EN 1995-1-2, at der

ikke sker indebrænding af træet i de første 60 minutter af

en standardbrandpåvirkning.

### Udvendige overflader:

K1 10 / B-s1,d0

Evt. regnskærm skal opfylde krav til B-s2,d0.

Mindre partier med et samlet areal på højst 20 % af ydervæggens areal og jævnt fordelt, kan udføres med regnskærm som materiale klasse D-s2,d2. Partierne placeres, så risikoen for brandspredning fra en brandmæssig enhed til en anden enhed minimeres.

Tag som BROOF(t2).

### Indvendige overflader:

Vægge: K1 10 / D-s2,d2

Loft: K1 10 / B-s1,d0

### Isolering:

B-s1,d0

### Altangange:

Bæreevne R 60 / D-s2,d2 - søjler kan evt. stå uinddækket og dimensioneres for indbrænding.

Dækket etableres med brandmodstandsevne EI60.

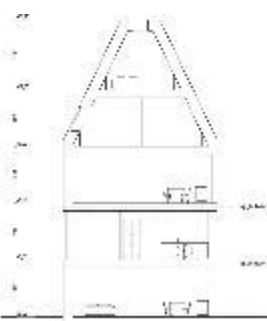
Gulve som gulvbelægning Dfl og loft som beklædning K1 10 / B-s1,d0

I de ender af altangangen, som ikke giver adgang til flugtvejstrappe, skal der være mulighed for redning. Altangange betyder at boliger kan indrettes uden redningsåbninger.

### Flugtvejstrappe:

Placeres i selvstændig brandsektion og vejrligssikres (lukkes)

Trapper som bygningsdel R 30 / A2-s1,d0 eller R 30 / D-s2,d2 med beklædning som mindst klasse K2 30 / A2-s1,d0 på undersiden og langs siderne



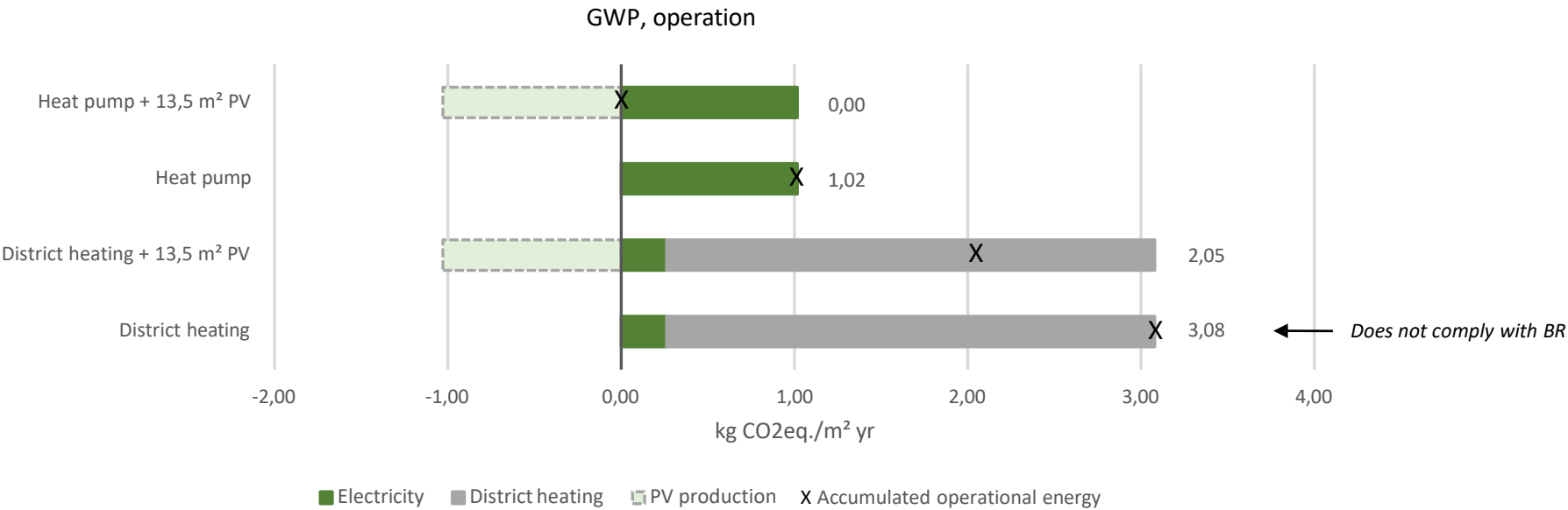
# Operational energy

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Calculated for a 3-story detached single family house

Operational energy during use highly affects the environmental profile of the building. Depending on location and site, different solutions are possible:

- District heating
- Heat pumps
- Contributions from PV-panels



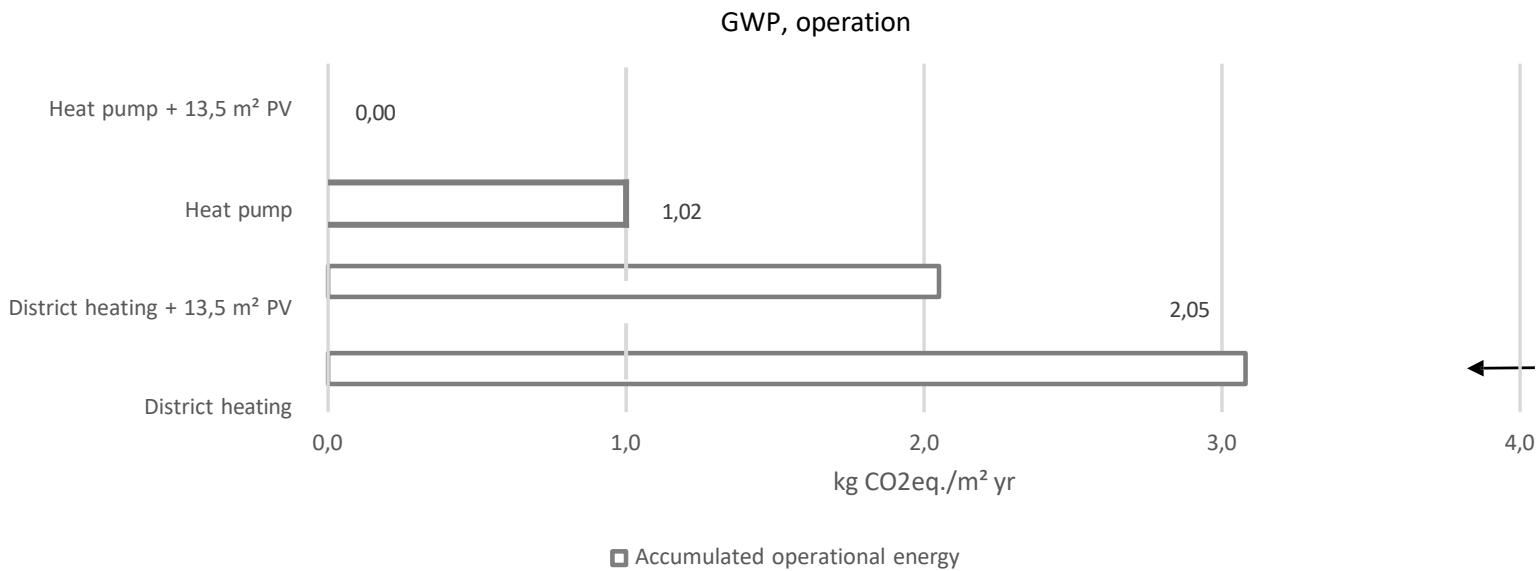
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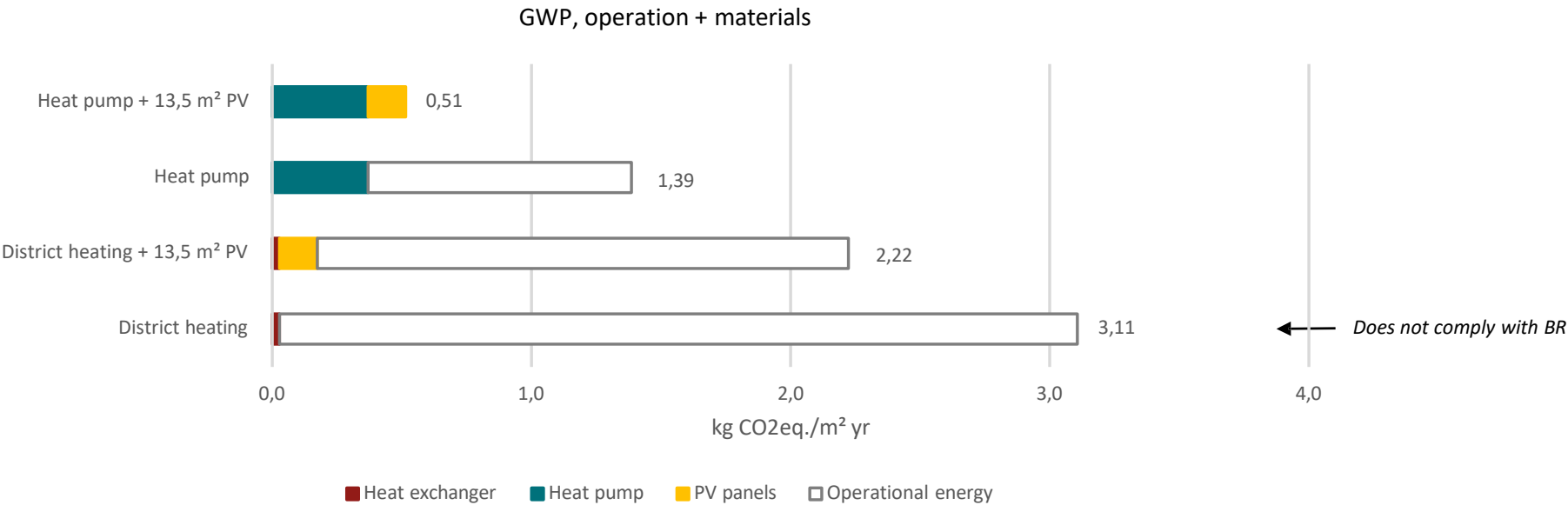
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