HOPPET

DETAILED RESOURCE MAPPING

SEPTEMBER 2019

Göteborgs Stad

LENDAGER GROUP

Detailed Resource Mapping - Hoppet

Created by Lendager Group for Göteborg Stad.

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LENDAGER GROUP

PREFACE

IMAGINE A WORLD WHERE THERE IS NO SCARCITY OF RESOURCES. A WORLD WHERE OUR CONSUMPTION, PRODUCTION AND CONSTRUCTION DOES NOT HAVE A NEGATIVE IMPACT ON OUR CLIMATE. WHERE WASTE DOES NOT EXIST, AND ECONOMIC GROWTH AND SUSTAINABILITY ARE EACH OTHER'S PREREQUISITES INSTEAD OF OPPOSITES. THAT WORLD IS REAL. AND THAT IS THE VERY REASON WHY I FOUNDED LENDAGER GROUP.

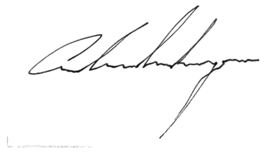
IN LENDAGER GROUP WE SEE A WORLD FULL OF EXISTING BUILDING MATERIALS - CONCRETE, BRICKS, WOOD, GLASS AND STEEL - WHICH CAN BE CIRCULATED INTO NEW MATERIALS WITH NEW FUNCTIONS AT A HIGHER VALUE. IF WE LOOK AT WASTE AS A RESOURCE, WE ARE ABLE TO DO SO MUCH MORE WITH FAR LESS.

TODAY, THE BUILT ENVIRONMENT IS RESPONSIBLE FOR 40% OF THE GLOBAL ENERGY CONSUMPTION AND 1/3 OF ALL CO_2 EMISSION. THIS IS FAR FROM GOOD ENOUGH. FORTUNATELY, THERE ARE GOOD NEWS. THROUGH CIRCULAR ECONOMY, WE CAN CHANGE THE BUILT ENVIRONMENT. INSTEAD OF IGNORING THE NEGATIVE CONSEQUENCES FROM OUR CURRENT PRODUCTION, WE CAN MAKE THE CONSTRUCTION INDUSTRY A POSITIVE DRIVER FOR SUSTAINABLE GROWTH AND IMPROVE QUALITY OF LIFE IN THE FUTURE. AT THE SAME TIME, WE CAN STRENGTHEN THE IDENTITY AND AESTHETICS OF NEW BUILDINGS.

NOW, MORE THAN EVER, IT IS POSSIBLE TO TAKE ACTION AND CREATE POSITIVE RESULTS ACROSS THE FOUR P´S (PURPOSE, PROFIT, PLANET, PEOPLE).

THIS IS WHY I APPRECIATE THAT GÖTEBORG STAD TAKES PART OF THIS JOURNEY. BY MAPPING RESOURCES IN BUILDINGS READY FOR DEMOLITION YOU ARE CONTRIBUTING TO IMPROVED RESOURCE CONSUMPTION. WITH THE CONSTRUCTION OF HOPPET, WE HAVE THE OPPORTUNITY TO SHOW THAT CIRCULATION OF BUILDING MATERIALS IS POSSIBLE WITHOUT COMPROMISING ON PRICE, QUALITY OR AESTHETICS. THAT REUSING BUILDING MATERIALS CAN BE GOOD BUSINESS. THAT THE BUILT ENVIRONMENT CAN AND MUST BE A PART OF THE SOLUTION.

KIND REGARDS



ANDERS LENDAGER
CEO AND FOUNDER
LENDAGER GROUP

EXECUTIVE SUMMARY

RESOURCE MAPPING FOR HOPPET

By building a new kindergarten of Hoppet as a fossil free construction it is essential to incorporate circular construction and demolition approaches. One of the first steps in this direction is to map the potentials for circulation of the materials in the area. This mapping will serve as a compass for the further development of the area and as an enabler to nourish the sustainable development of the Hoppet kindergarten and Göteborg Stad.

MATERIALS WITH POTENTIALS

Based on the materials mapped, two categories of material circulation appear:

1. A category of materials that should be circulated due to their embedded CO_2, quantity and quality (including structural wood, wood cladding, concrete roof tiles and glass).

2. Another category of materials requiring a local expert in recycling of materials through a downcycling process (including concrete for road filling, plastic, vinyl/linoleum and mineral wool). There is potential for upcycling of some of the materials which should be further assessed before deciding whether they should be downcycled.

Due to quantities mapped here, we suggest considering supplementing the material amounts with materials from other sites ready for renovation/demolition, in order to ensure the quantity required for this business case as well as covering needs in new construction projects.

MATERIALS FOR CIRCULATION

Several materials stand out due to their amounts, CO_2 saving potential and output numbers. The most common materials include:

Glass

Despite the rather small amount of glass contained, there is a high CO_2 saving potential. The double layer glazing glass are suitable for direct reuse in interior partition walls. It should be further assessed whether the three layer glazing windows are to be upcycled as outdoor windows. This can be tested when dismounting the windows from the building.

Concrete roof tiles

The concrete roof tiles are deemed to be in very good condition, why we recommend considering direct reuse or upcycling of these in future constructions.

Wood cladding & structural wood

There is a large amount of wood contained across the four buildings, it makes up the largest amount of material output in terms of reference houses. In addition, it is generally of high quality and is preserved in good condition. The wood can be turned into performing wall cladding both inside and outside. That is why direct reuse should be considered. Additionally, wood is known to be a flagship in the Swedish construction identity.

TOTAL AMOUNTS OF MATERIALS

Material	Amount	Unit
Asfalt Roofing	657	m2
Concrete Roof Tile[1]	1.974	m2
Concrete[2]	460	m3
Glass	251	m2
Mineralwool	365	m3
Plastic Roof	241	m2
Steel	1,5	ton
Vinyl/Linoleum	2.292	m2
Wood Cladding[3]	1.583	m2
Structural Wood[4]	95	m3

POTENTIAL CO_2 SAVINGS

Total
CO_2 savings
281.174 kg CO_2-eq
by directly reusing all the materials

Total
CO_2 savings
124.723 kg CO_2-eq
by directly reusing all the materials except concrete which will be reused as aggregate in new concrete

281.174 kg CO_2-eq
can potentially be saved by directly reusing all the materials which corresponds to

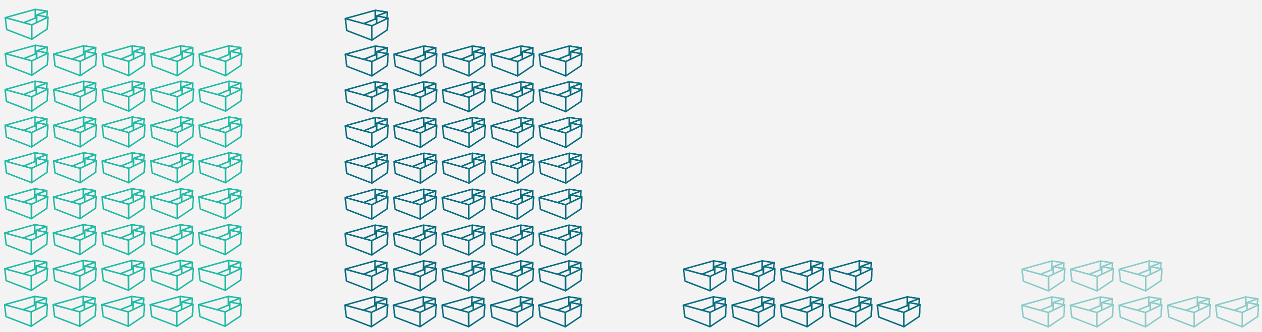
66 avg Swedes
annual CO_2 emission

or

100 car owners
taking their bike for an entire year

NEW MATERIALS

Number of reference houses based on Lendager UP products with materials from this mapping:



UP Wood Facade
41 reference houses

UP Roof Tile Facade
41 reference houses

UP Concrete
9 reference houses

UP Window
8 reference houses

One reference house consists of a 4-person appartment of 100 m² with a concrete structure

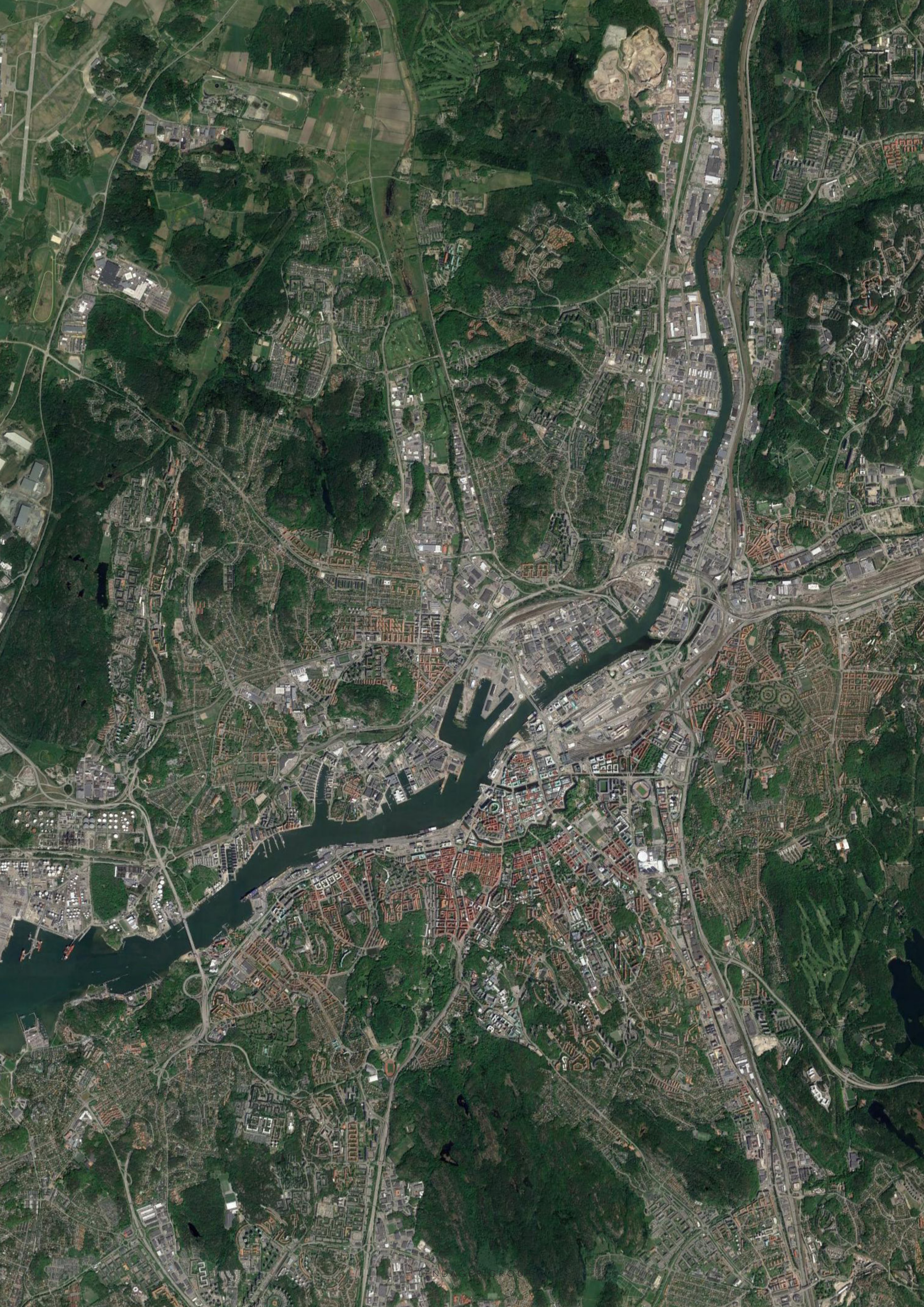
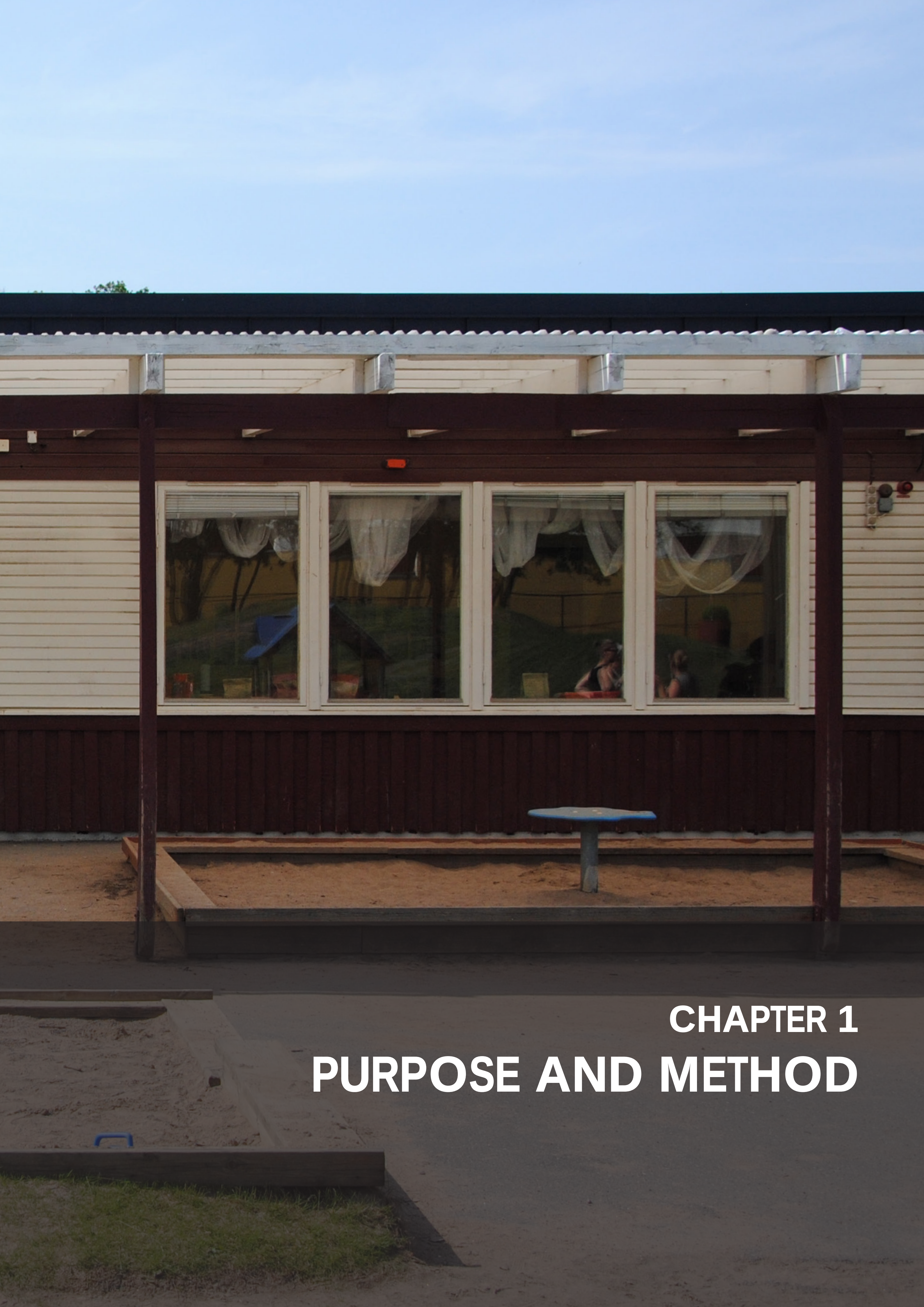


TABLE OF CONTENT



CHAPTER 1

PURPOSE AND METHOD

INTRODUCTION

GÖTEBORG STAD AS FRONTRUNNERS

The premises authority in Göteborg Stad are investigating how to build a fossil free preschool; Hoppet. The project is part of Göteborg Stad's goal of creating the conditions to reach a climate-neutral city with a sustainable and reduced emission level of greenhouse gases by 2050.

One of the central processes to achieve fossil free construction is circulating existing contruction materials. Göteborg Stad is approaching the demolition of four buildings and wishes to explore the potentials of reusing these construction materials in the new Hoppet preschool. With this strong emphasis on developing Hoppet based on circular economy criteria - through reuse, upcycling and downcycling - Göteborg Stad is set to reduce the project's use of resources and lower the environmental impact while strengthening the identity, affiliation, and appeal of the building.

HOPPET AS A STARTING POINT FOR RESOURCE OPTIMIZATION

This resource mapping is the starting point for circular architecture created from local waste materials from Göteborg. This approach creates a platform for the development of elegantly processed materials with whole new aesthetics in architecture and design, saving CO_2 and preserving the architectural heritage in new buildings. Furthermore, processing of the waste materials promotes the creation of local jobs in the construction phase.

RESOURCE MAPPING

This report presents the results from a detailed resource mapping of four selected buildings followed by an idea catalogue with the inspiration for potential circulation methods and recommendations for the next step.

THE BUILDINGS

This resource mapping covers four buildings that today function as children institutions. The buildings today are in design and its layout is typical of 1980's and 1990's temporary Swedish construction, consisting of one store built of wood and concrete.

Buildings:

- Building on Backa Kyrkogata 3: 654m2
- Building on Backa Kyrkogata 7: 675m2
- Building on Backa Kyrkogata 9: 396m2
- Building on Biskopsgatan 8: 687 m2
- **Total size: 2412 m2**

REPORT STRUCTURE

Chapter 1: Purpose and Method
Introduction to circular economy in construction, processes and methods behind a detailed resource mapping.

Chapter 2: Detailed Resource Mapping
Detailed mapping showing material type, amount, unit, location and potential for circulation for each building.

Chapter 3: Hoppet Material Bank
Circulation potential across buildings are presented describing total amounts, CO_2 saving potential and amount of output materials.

Chapter 4: Idea Catalogue
Ideas for circulation are presented across structural wood, wood cladding and concrete roof tiles.

Chapter 5: Next step
Outro with recommendations for next steps and an outline of a circular construction process.

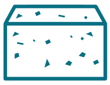
POTENTIALS

STRUCTURAL WOOD

Amount: 95 m^3
CO_2-eq: 3.812 kg

WOOD CLADDING

Amount: 1.583 m^2
CO_2-eq: 12.224 kg



CONCRETE

Amount: 460 m^3
CO_2-eq: 28.277 kg

MATERIAL VALUE

Our current relation to the worlds resources is paradoxical. We are continuously exploiting new resources from the Earth, while discarding large amounts of materials that could be reused.

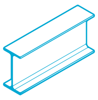
Fortunately, we can change the way we do things. Many actors have already discovered the large potential for both environmental and financial gains of going circular instead of linear.

The resource mapping of the four selected buildings in Hoppet illustrates the big potential for usable materials that are already present in existing buildings. Thus, it becomes mandatory to use the sites as urban mines from which to harvest materials for new buildings. The reason why Hoppet should reuse, downcycle and upcycle is based on three general considerations of the value of the materials; identity, environment and economy.

IDENTITY VALUE

The premises administration in Göteborg Stad are investigating and constructing a fossil free preschool, Hoppet. The project is an important part of the Gothenburg Stad´s goal of achieving a climate neutral city.

The project involves demolishing four buildings that today function as children institutions, all containing a fair amount of building materials with potential for circulation. The buildings are largely characterized by areas with typical wooden structures and cladding. If dealt with properly, this can create an opportunity for new architectural expressions when building the Hoppet preschool. Compared to other urban areas being developed, the cultural value tends to be overlooked. Hoppet has the opportunity to brand itself as a preschool with a very special atmosphere, architecture and identity.

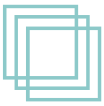


STEEL

Amount: 1.5 ton
CO_2-eq: 2.969 kg

CONCRETE ROOF TILES

Amunt: 1.974 m^2
CO_2-eq: 8.348 kg



GLAS

Amount: 251 m^2
CO_2-eq: 14.939 kg

ENVIRONMENTAL VALUE

The built environment is one of the most polluting industries due to the high resource consumption and large CO_2 footprint. The built environment is responsible for 40% of the global CO_2 emission, and the Swedish built environment alone was accountable for more than 9.8 million tons of construction waste in 2016.

By circulating the materials in the existing buildings, we can reduce CO_2 emissions, minimize the amount of waste generated and decrease the use of virgin materials.

Here, we have mapped 1.244 tons of building materials in the four existing buildings. By circulating the existing materials, it is possible to save 124.723 kg CO_2-eq in the new construction project. This is the equivalent of 21 Swede's average annual CO_2-emissions or having 45 car drivers take their bike for an entire year.

ECONOMIC VALUE

Reusing, upcycling and downcycling represent a quantifiable economic opportunity to anyone who wants to explore this path. When dealing with existing materials in demolition projects, the usual approach is to turn it into waste as the industry is largely unaware of the business opportunity to do otherwise. It is a lost chance, as value is literally wasted. By building with circulated materials, value is created through the development of an identity/ branding, as well as preservation of the environment. The most significant difference between circulated and virgin materials is found in the cost structure. Circulated materials are free of charge as raw materials and only demand expenditure in terms of harvesting and treatment. A process that creates local jobs, long-lasting branding value and new business opportunities. Furthermore, these new solutions need only to be developed once, but have the potential to be used again and again – thereby creating scalability opportunities for further financial benefits.

MATERIAL POTENTIALS

DEMAND FOR MATERIALS FOR CIRCULATION

Amongst the properties of different materials, there are some defined parameters that are essential to consider when developing the circular building industry, as well as when assessing the specific material's circulation potential. These are as follows:

Size

Every time a material is trimmed, the possibilities for circulation change. It is often the case that material sizes are modified throughout the demolition processes, as cutting of some elements might be required. This makes it complex to obtain specific sizes. Therefore, we should always strive to keep a certain size in the materials to avoid unnecessary cascades.

Volume

In most buildings, a certain amount of materials is needed. As an example, it is often important that you identify several windows and doors of the same size, enough concrete with the same strenght, enough wood to cover a whole facade, etc. In buildings where circulated materials are used, some circulated materials can be easily combined with virgin materials (e.g. windows) where others can be more arduous with other materials due to technical and aesthetic requirements.

CO_2

There are considerable differences in the amount of CO_2 embedded in different construction materials. Classical sinners include concrete, windows and bricks as they are CO_2 demanding in their production. When materials are selected for circulation, the criteria should be based on both the material's CO_2 footprint alongside with the amounts available. Turning, for instance, wood into a very relevant material, despite its low CO_2 per unit footprint, due to the large amounts present in certain project.

Cleanliness and condition

Circulation of building materials require purity - some more than others. Here, it is important to work with as highly pure materials as possible so that we are not forced to downcycle because of e.g. scratched windows, impregnation of wood or dirt, and insulation material in concrete.

Access

In a building process, the availability of necessary building materials is essential. Here, it can become a challenge to ensure access to specific windows, concrete, wood for flooring etc. in the right time for a particular building. An overview of own and collaborative partners' material flow will help significantly in sourcing and, thus, also improve the circulation result.

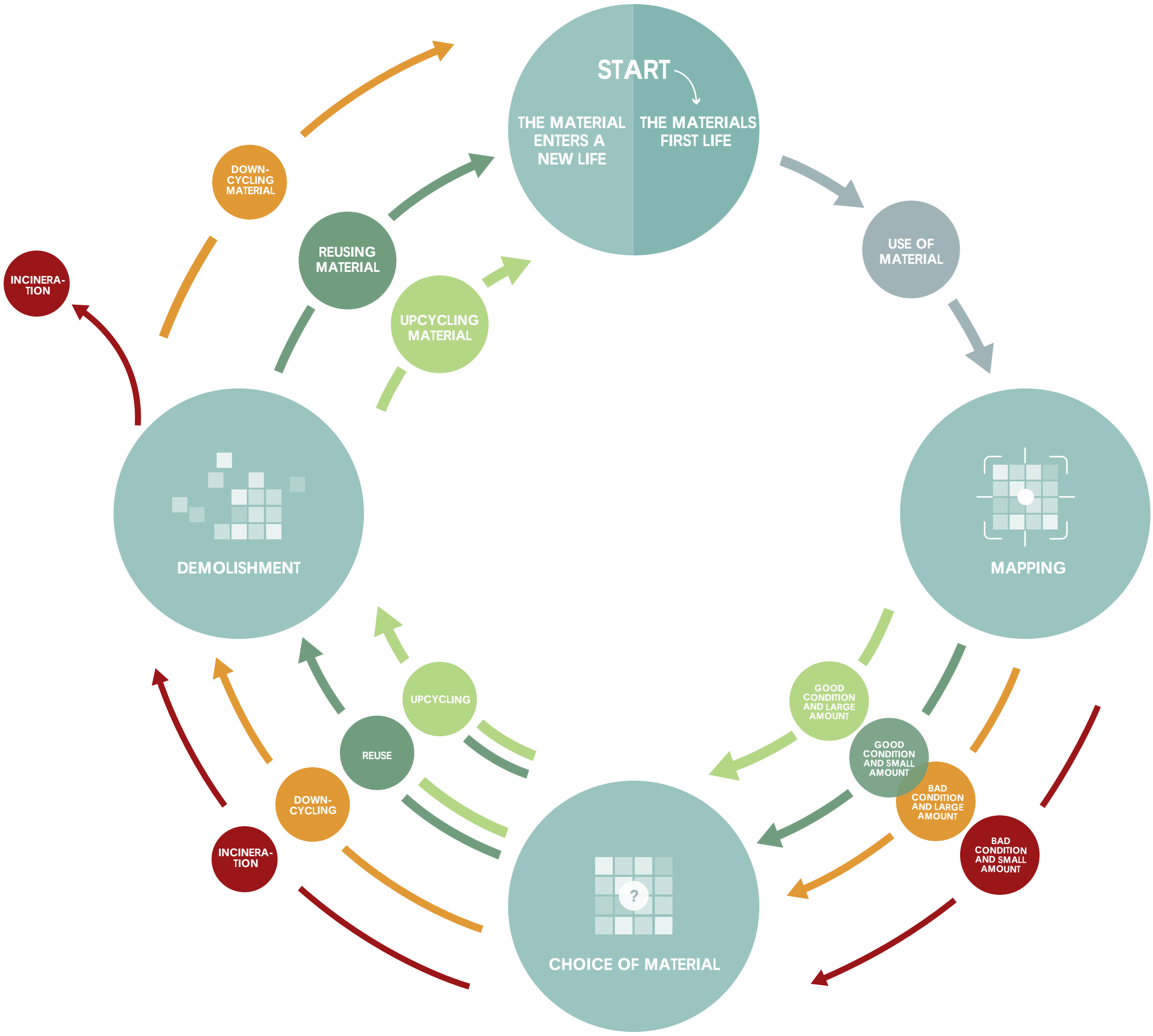
Strenght

When sourcing building materials based on virgin resources, you know exactly how much the material can bend, carry, hold, etc. This knowledge is less quantifiable in the use of circulated materials as the materials may have been subjected to different wear forms. It is therefore essential to ensure the strength and quality of the materials in a circulation process through measurements and tests.

Aesthetics

Sustainable construction is durable construction. And durable construction is not only about strength of materials but also about the aesthetic expression. Therefore, when materials are selected for circulation there should always be room for materials with a special aesthetic being, for example, a staircase with a unique expression or wood construction with a selective shape.

PROCESS FOR MATERIAL CIRCULATION



DETERMINATING MATERIAL CIRCULATION

When a material has to be evaluated for circulation, there are a number of different factors to be considered. Only when the quantity and condition of the material have been assessed, it can be decided which type of circulation will be suitable in order to give the material a new life.

For example; is there enough brick wall to cover the new m² facade to be built, and is the quality good enough to comply with applicable environmental requirements, safety requirements, and aesthetic expressions?

When we assess the potential of materials, we have a particular focus on two parameters: Quality and quantity.

The process in the above figure is based on a quest for optimized resource consumption. It is a process to enforce the material supply for the circular building market. The process is not an integral part of all demolitions and contractors' daily lives - yet.

PROCESS AND METHOD

The purpose of this detailed resource mapping is to create an insight into the potentials of circulating materials across the four buildings that are ready for demolition. The mapping will give an understanding of:

1. Most frequently represented materials
2. Overall quantities of materials
3. Potentials for CO_2 savings across materials
4. Potential new output materials based on this mapping

The resource mapping has been carried out on the basis of a review of drawing materials from the four buildings, a physical mapping and a finishing data analysis. See diagram of process on next page. In the physical mapping we have verified the potentials and available materials. The results of this mapping can be used to define different materials' circulation potential and further development of new building materials based on the existing materials.

The following is a description of the most essential basis for the data:

MATERIAL CATEGORIES

The resource mapping focuses primarily on the material categories: concrete, insulation, asphalt, wood, glass, concrete, concrete roof tiles, mineral wool, plaster, plastic, steel and vinyl/linoleum. The categories can contain different types of building materials with different potentials for circulation. For example, the concrete category both includes concrete tiles and concrete floor slabs.

AMOUNTS

All numbers are indicative and the material state and amount should be verified and detailed when circulating the materials. This is due to the lack of knowledge of potential pollution and hidden treatments.

The amounts specified per idea in the idea catalogue are collective amounts. As an example this means that there will not be materials for both shingles and interior based on the wood mapping on the specific sides.

VISIBLE MATERIALS

As the resource mapping is conducted on buildings that are still in use we have focused on mapping the visible materials combined with materials derived from the drawings. This means that materials like piping, wires etc. are not included here.

UNITS

When describing the material amounts we have used different units fitting to the specific materials. This is done to create a better understanding of the amounts of building materials you can get for a potential circulation. Flat materials such as floors, ceilings, roofs, and facades are stated in m^2. Materials formed by casting (such as concrete) or milling (construction wood) are stated in m^3 as this gives a better indication of the circulation potential. When materials are collected for comparison, the unit ton is used.

CO_2-CALCULATIONS

The calculations for potential CO_2 savings are based on EPD's of different construction materials. Sources of the EPD's include EPD Danmark, International EPD System and Norwegian EPD Foundation.

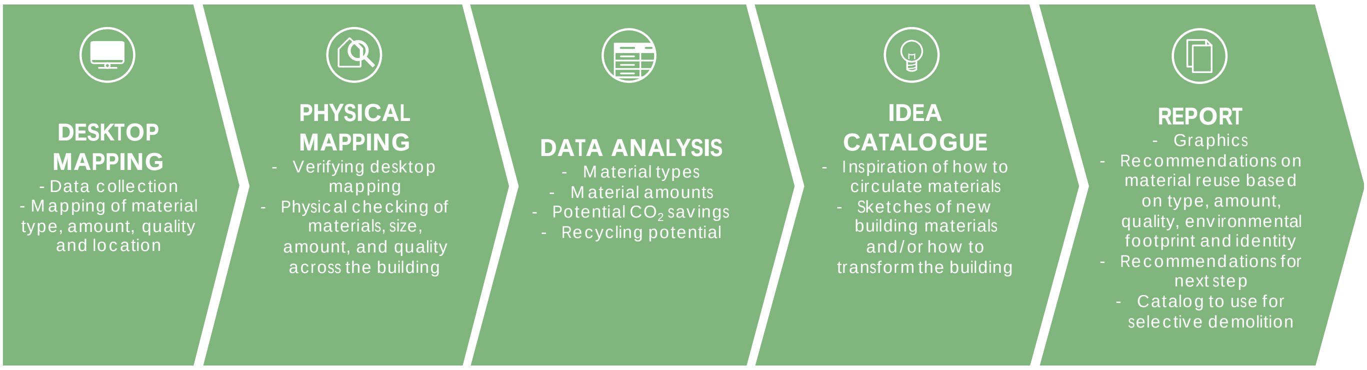
MATERIALS FOR NEW CONSTRUCTION

The calculation of material amounts for new construction is based on the experiences of Lendager Group with development of circulated building materials for the projects Resource Rows, Pelican Selfstorage and Upcycle Studios.

KG / CUBIC METER:

To calculate the material amounts in ton, we have made estimation on kg per cubic meter for each material. These estimations are based on general densities of each material. The density can vary between different types of concrete as an example, leading to a minor variation in actual amounts.

GRAPH OF PROCESS FOR FULL RESOURCE MAPPING

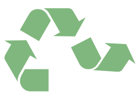


REUSE, UPCYLING AND DOWNCYCLE

Throughout the resource mapping, different terms are used to uncover the potential for circulation. Circulation is used as an umbrella term for reusing, upcycling and downcycling. The definition of the terms are as follows:

REUSE

Reuse covers the use of a material or product used for the same purpose or function. Reuse includes both processes where materials are directly reused and where the materials undergo different kinds of light processing.



UPCYCLING

Upcycling describes the conversion of residual materials or waste into a new product that has a higher material and/or economic value. This happens through gentle processing and the lifetime of the material is typically extended.

DOWNCYCLING

Downcycling describes the process by which the materials extracted is used to create a new product with a lower economic and/or material value. Here the materials go through rough processing degrading the material value.

CHAPTER 2
DETAILED RESOURCE MAPPING

OVERVIEW

The following chapter presents the actual resource mapping of the buildings marked on the maps on the next page. This chapter is structured so that each building is reviewed with the following:

Page 1:
- The location of the building
- Schedule of mapped materials, ID no., element, quantity, unit, location and circulation potential.

Page 2:
- Drawing of the building

Page 3-4:
- Detailed floor plan with all materials marked by ID. This is to illustrate the location of materials for future harvesting/selective demolition.

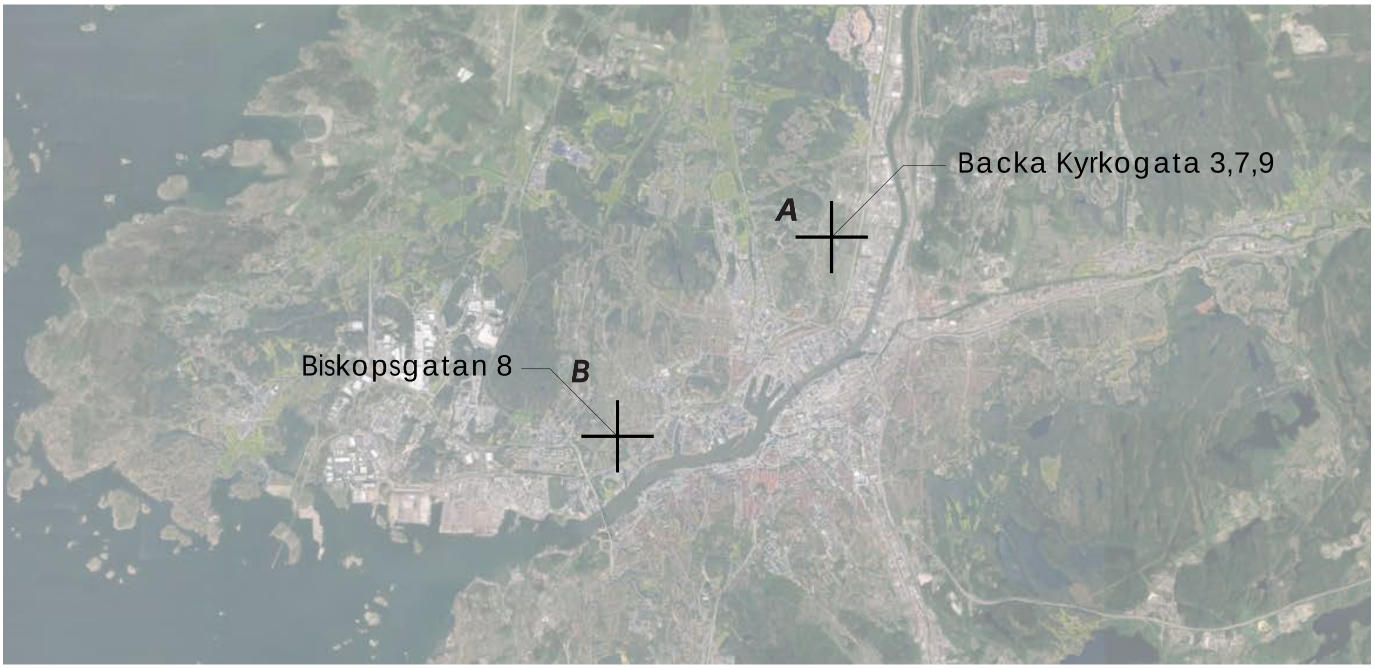
Page 5:
- Pictures of the mapped materials in the building with corresponding reference number for the material scheme

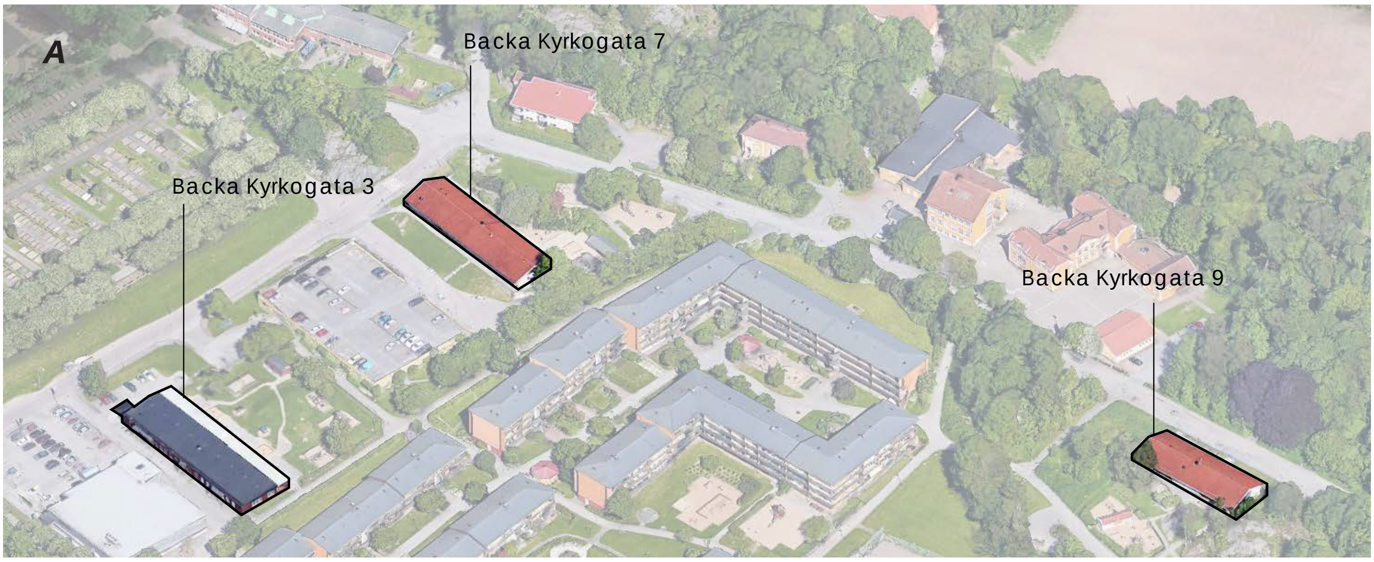
Page 6:
- Pie chart of total quantities across the mapped materials in the building in focus. The total quantity is calculated in tonnes to make figures comparable. This distorts the numbers slightly, as concrete has a higher density than most building materials. We therefore ask the reader to take this into consideration.

The mapping can be used to get an overview of the materials and amounts present in each of the four building. At the same time it can be used for the later phase of harvesting materials / selective demolition. This chapter can be used to identify location of the materials chosen for circulation.

THE BUILDINGS

Building Name	**Backa Kyrkogata 3**
Address	PXVG+7H Gothenburg, Sweden
Construction Year	1982*
Total Floor area (m^2)	654
Current Function	Kindergarden
Building Name	**Backa Kyrkogata 7**
Address	Backa Kyrkogata 7, 422 58 Hisings Backa, Sweden
Construction Year	1976*
Total Floor area (m^2)	675
Current Function	Kindergarden
Building Name	**Backa Kyrkogata 9**
Address	PXRH+54 Gothenburg, Sweden
Construction Year	1971*
Total Floor area (m^2)	396
Current Function	Kindergarden
Building Name	**Biskopsgatan 8**
Address	Biskopsgatan 8, 418 77 Göteborg, Sweden
Construction Year	2013*
Total Floor area (m^2)	687
Current Function	Kindergarden
Total Size (m^2)	**2412**


Backa Kyrkogata 3,7,9
A
Biskopsgatan 8
B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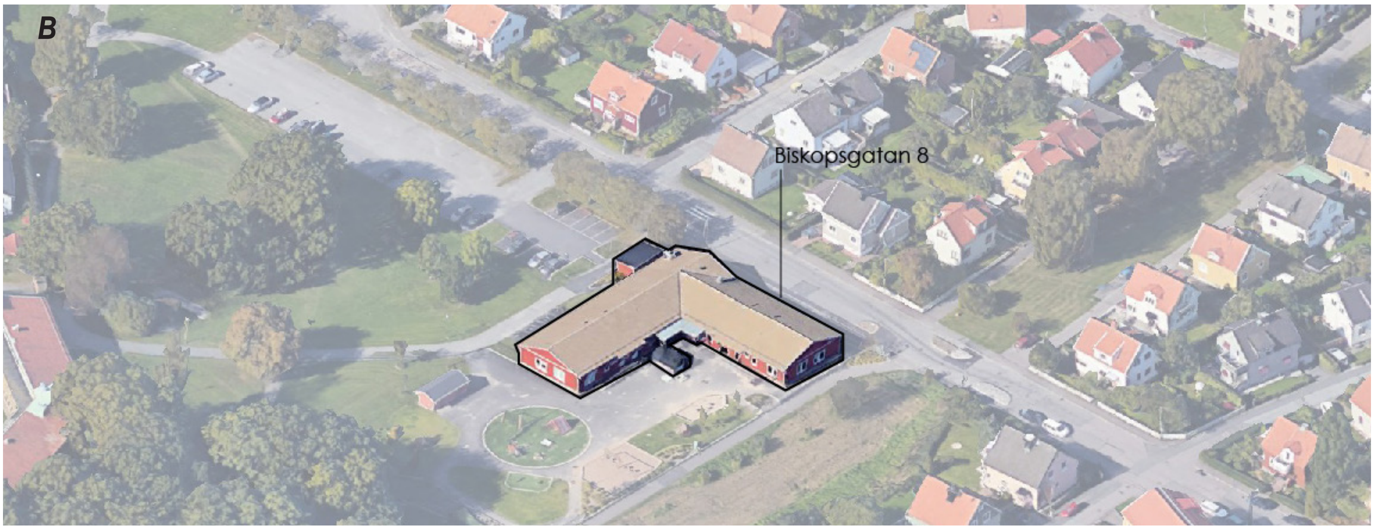
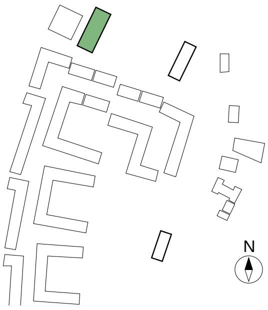
Backa Kyrkogata 7
Backa Kyrkogata 3
Backa Kyrkogata 9


B
Biskopsgatan 8

1 . BACKA KYRKOGATA 3

MATERIAL OVERVIEW

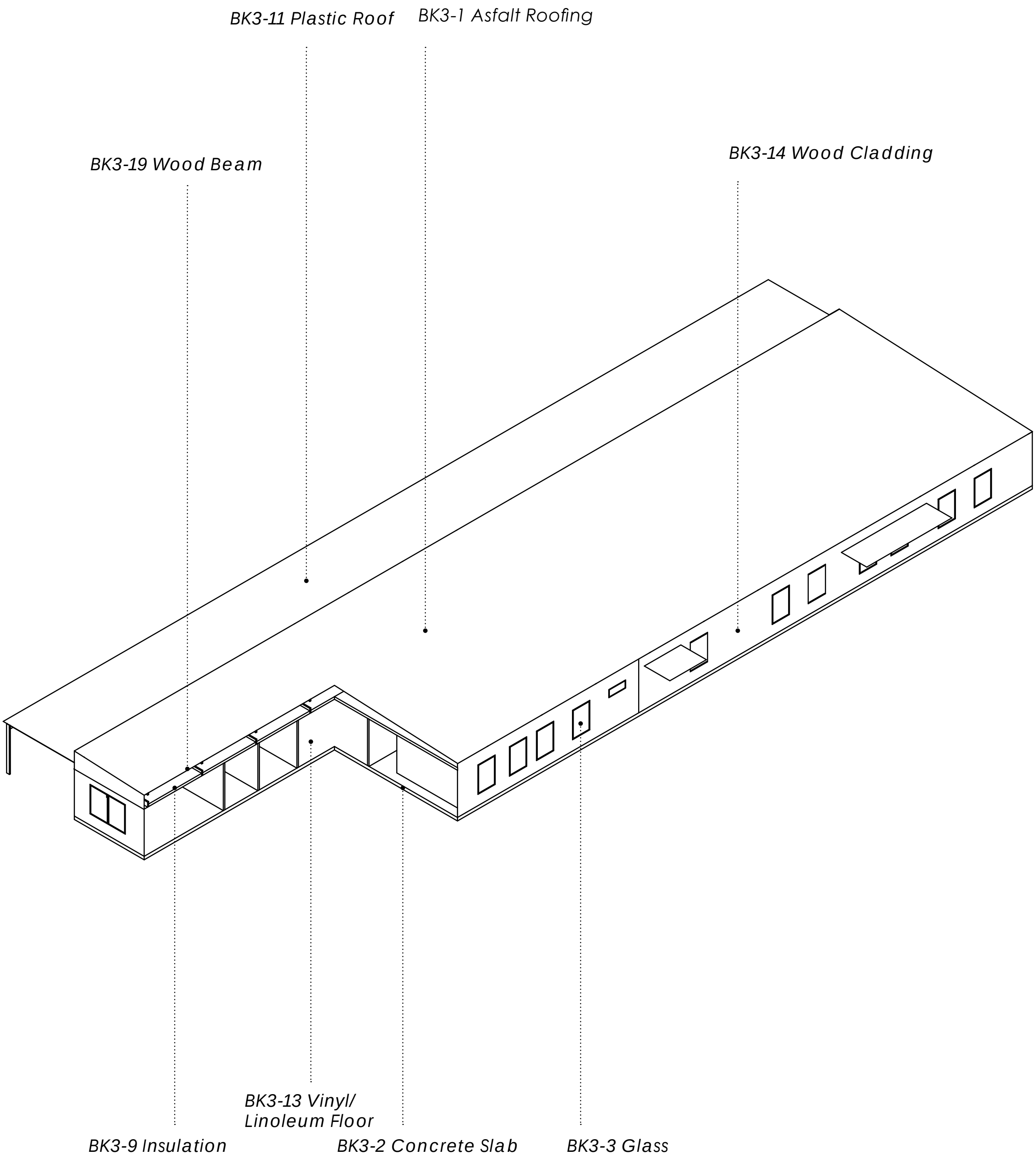
Address: Backa Kyrkogata 3, 422 58 Hisings Backa, Sweden
Construction Year: 1982
Totalt area: 654 kvm.
Structure: Wood



Material List

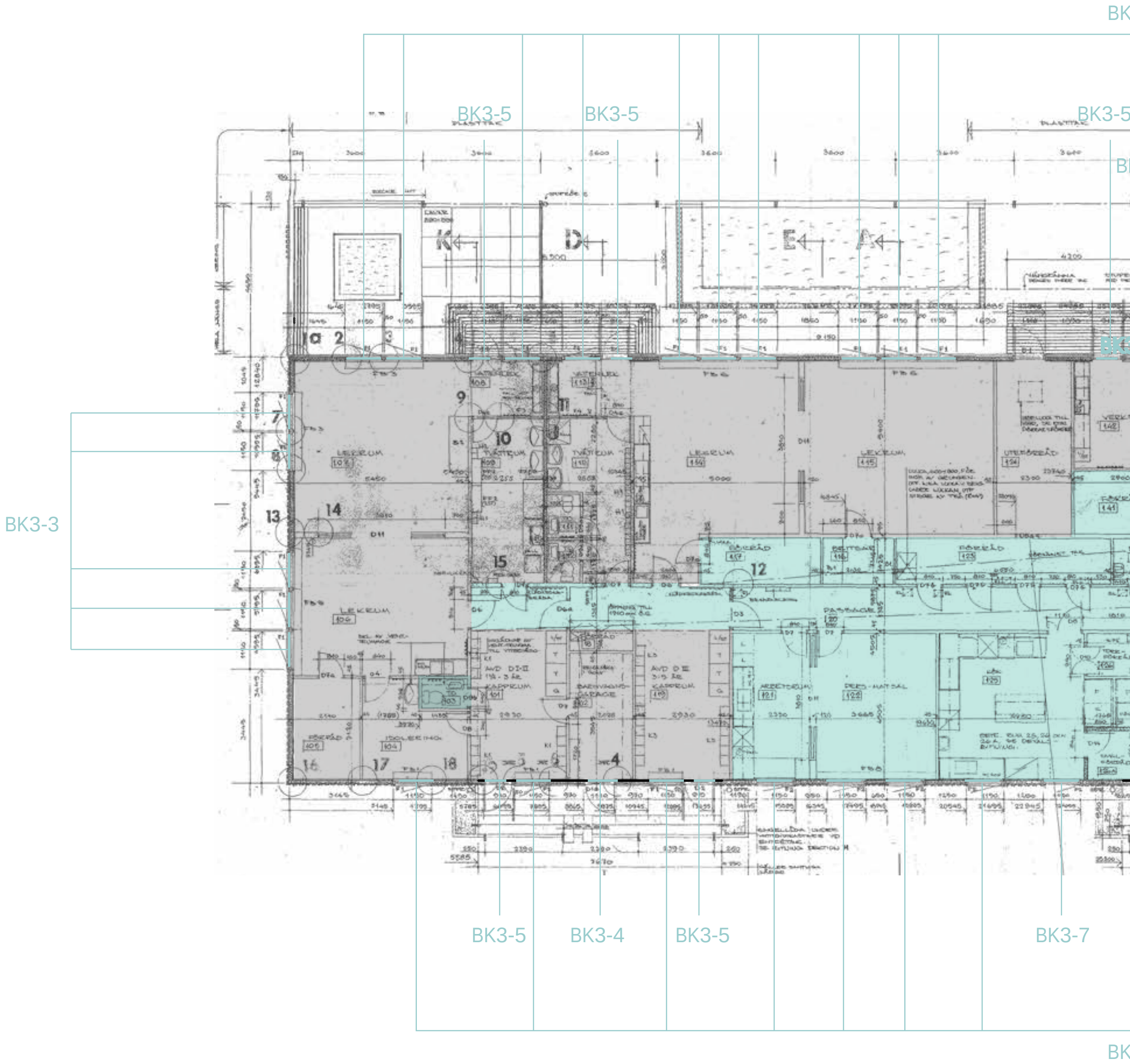
ID	Material	Element	Stk	Amount	Unit	Reuse	Upcycle	Downcycle
BK3-1	Asphalt	Roofing	-	657	m2			✓
BK3-2	Concrete	Slab	-	654	m2		✓	
BK3-3	Glass	2-glazing window	46	77,28	m2		✓	
BK3-4	Glass	2-glazing window	1	0,98	m2		✓	
BK3-5	Glass	2-glazing window	9	7,02	m2		✓	
BK3-6	Glass	2-glazing window	1	0,71	m2		✓	
BK3-7	Glass	2-glazing window	1	0,42	m2		✓	
BK3-8	Mineralwool	Acoustic panel	-	157	m2	✓		
BK3-9	Mineralwool	Insulation	-	113,5	m3	✓		
BK3-10	Plaster	Acoustic panel	-	270,99	m2	✓		
BK3-11	Plastic	Polycarbonate roofing	-	241	m2		✓	
BK3-12	Steel	Drainage	-	0,12	ton	✓		
BK3-13	Vinyl/Linoleum	Floor	-	654	m2			✓
BK3-14	Wood	Cladding	-	328	m2	✓		
BK3-15	Wood	Construction	-	16	m3	✓		
BK3-16	Wood	Window frame	-	271	m	✓		
BK3-17	Wood	Skirting board	-	323	m	✓		
BK3-18	Wood	Particle board	-	1,86	m3	✓		
BK3-19	Wood	Roof truss	-	5,3	m3	✓		

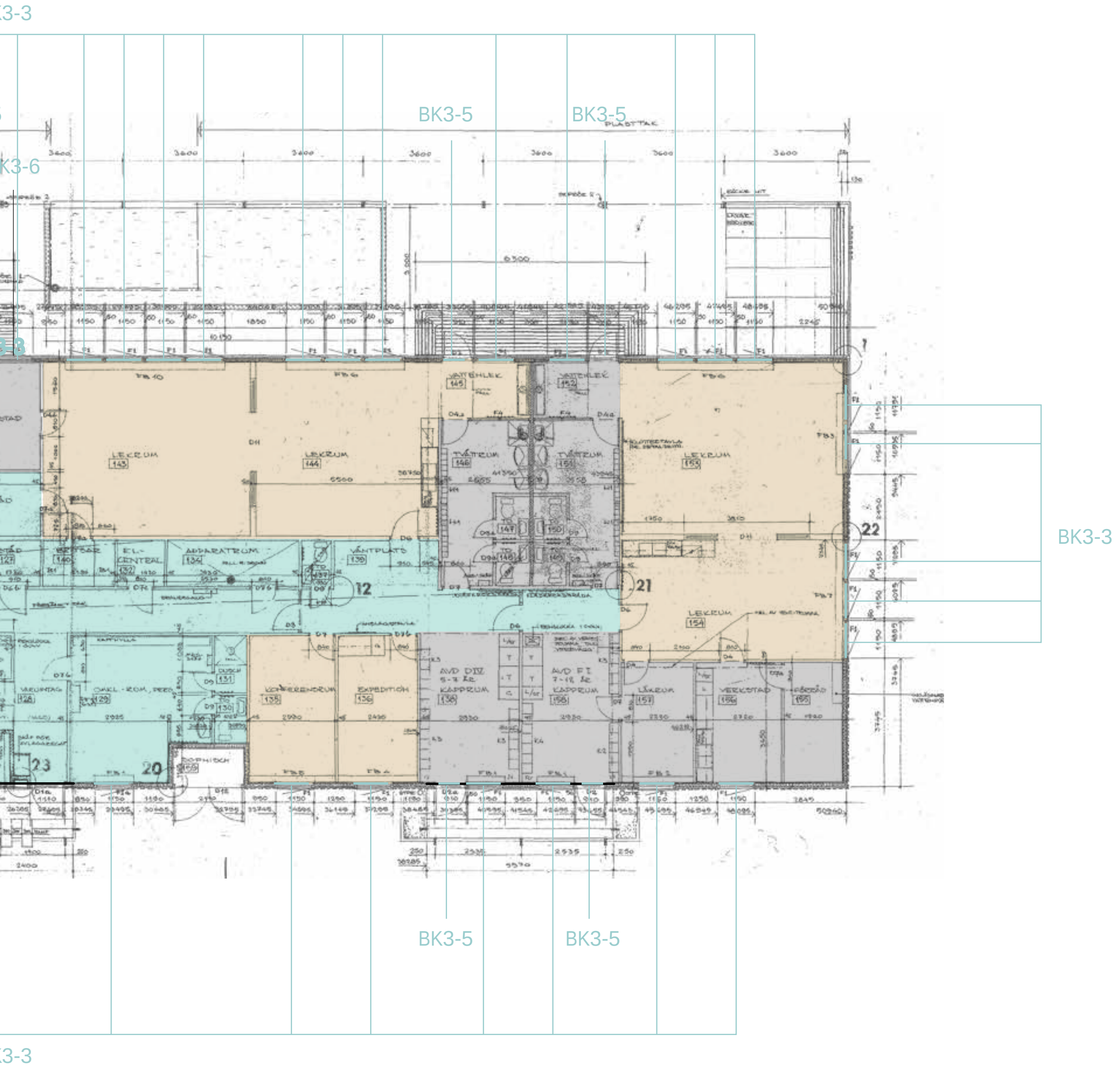
BUILDING OVERVIEW



1 . BACKA KYRKOGATA 3

FLOORPLAN





Mineral wool

Plaster Acoustic Panel

1 . BACKA KYRKOGATA 3

PHOTO REGISTRATION

BK3-1 *Asphalt Roofing*

BK3-2 *Concrete Slab*

BK3-3 *Glass*

BK3-4 *Glass*

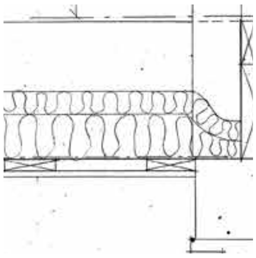
BK3-5 *Glass*

BK3-6 *Glass*

BK3-7 *Glass*

BK3-8 *Acoustic Panel*

BK3-9 *Insulation*



BK3-10 *Plaster Panel*

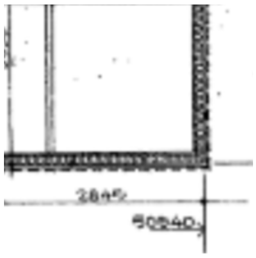
BK3-11 *Plastic Roofing*

BK3-12 *Steel*

BK3-13 *Vinyl/Linoleum Floor*

BK3-14 *Wood Cladding*

BK3-15 *Wood Construction*



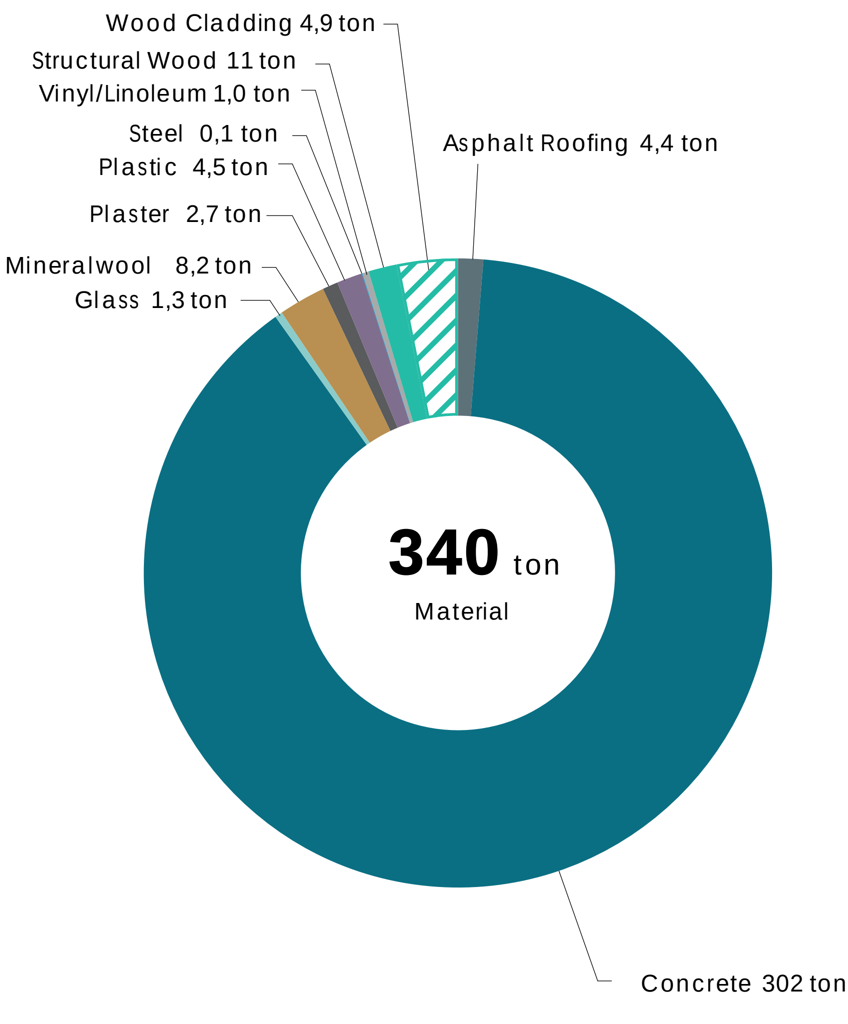
BK3-16 *Window Frame*

BK3-17 *Skirting Board*

BK3-18 *Plywood*

BK3-19 *Beam*

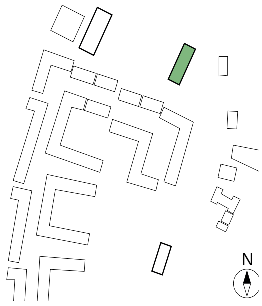
MATERIAL AMOUNTS



2 . BACKA KYRKOGATA 7

MATERIAL OVERVIEW

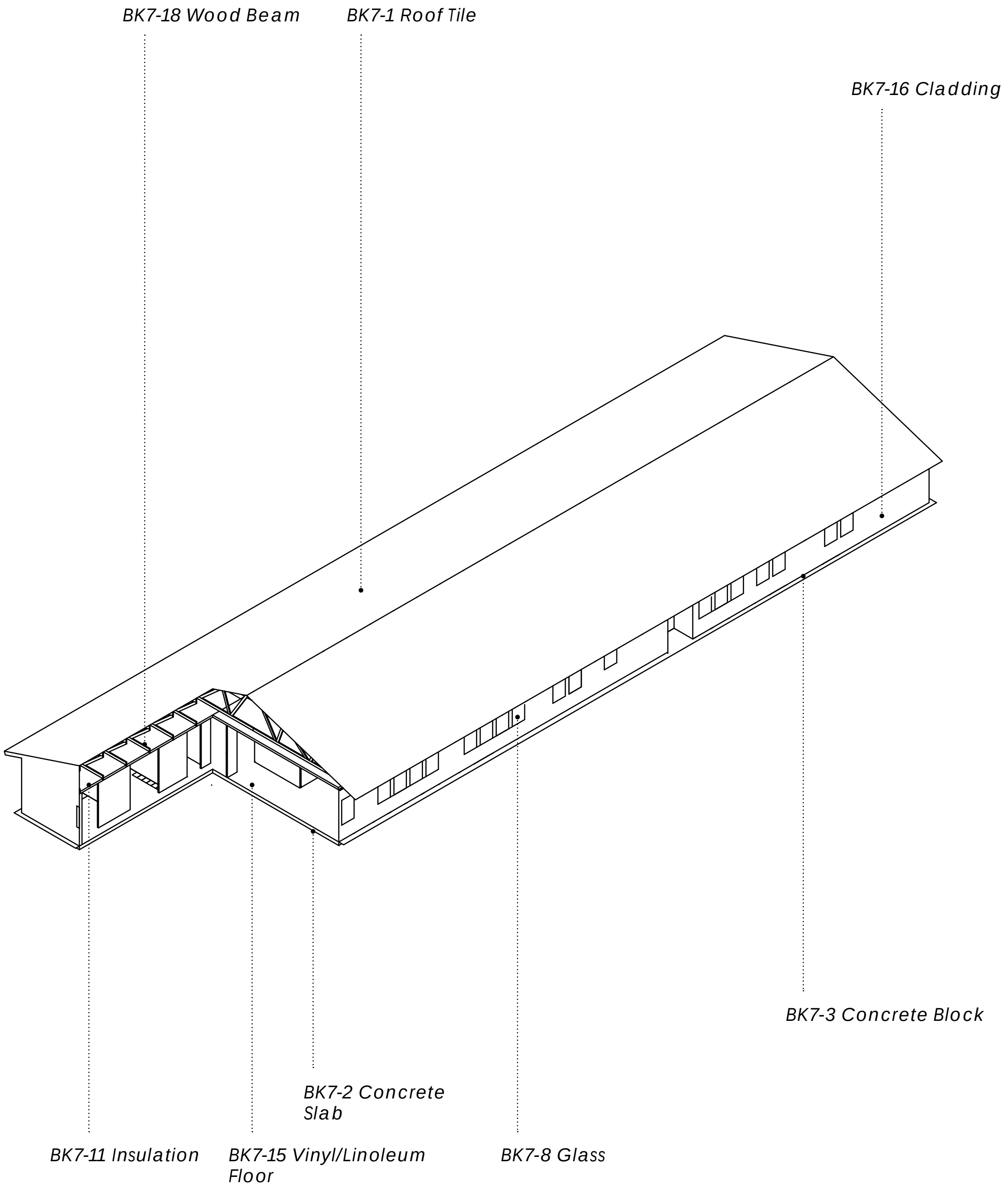
Address: Backa Kyrkogata 7, 422 58 Hisings Backa, Sweden
Construction Year: 1976
Total Area: 675 sqm
Structure: Wood



Material List

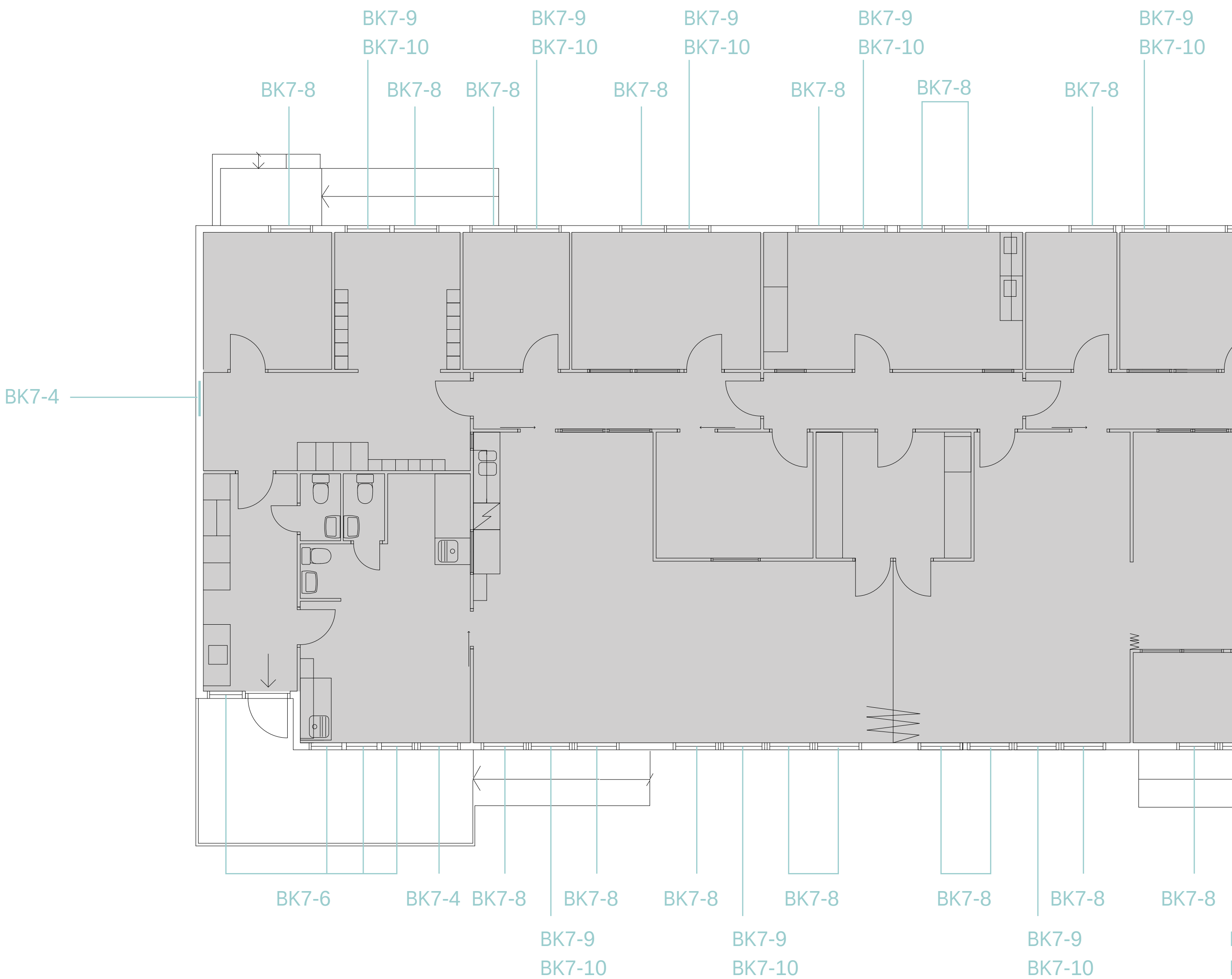
ID	Material	Element	Stk	Amount	Unit	Reuse	Upcycle	Downcycle
BK7-1	Concrete	Roof tile	-	683	m2	✓		
BK7-2	Concrete	Slab	-	553	m2		✓	
BK7-3	Concrete	Pavementblock	-	6,95	m2		✓	
BK7-4	Glass	2-glazing window	30	33	m2		✓	
BK7-5	Glass	2-glazing window	13	10,66	m2		✓	
BK7-6	Glass	2-glazing window	13	2,21	m2		✓	
BK7-7	Glass	2-glazing window	3	2,82	m2		✓	
BK7-8	Glass	2-glazing window	3	1,5	m2		✓	
BK7-9	Glass	2-glazing window	8	1,6	m2		✓	
BK7-10	Glass	2-glazing window	1	0,3	m2		✓	
BK7-11	Mineralwool	Insulation	-	79,36	m3	✓		
BK7-12	Plaster	Acoustic panel	-	508	m2	✓		
BK7-13	Steel	Grating	8	0,41	ton	✓		
BK7-14	Steel	Drainage	-	0,17	ton	✓		
BK7-15	Vinyl/Linoleum	Floor	-	553	m2			✓
BK7-16	Wood	Cladding	-	266	m2	✓		
BK7-17	Wood	Construction	-	15,7	m3	✓		
BK7-18	Wood	Roof truss	-	11,7	m3	✓		
BK7-19	Wood	Window frame	-	232	m	✓		
BK7-20	Wood	Skirting board	-	190	m	✓		

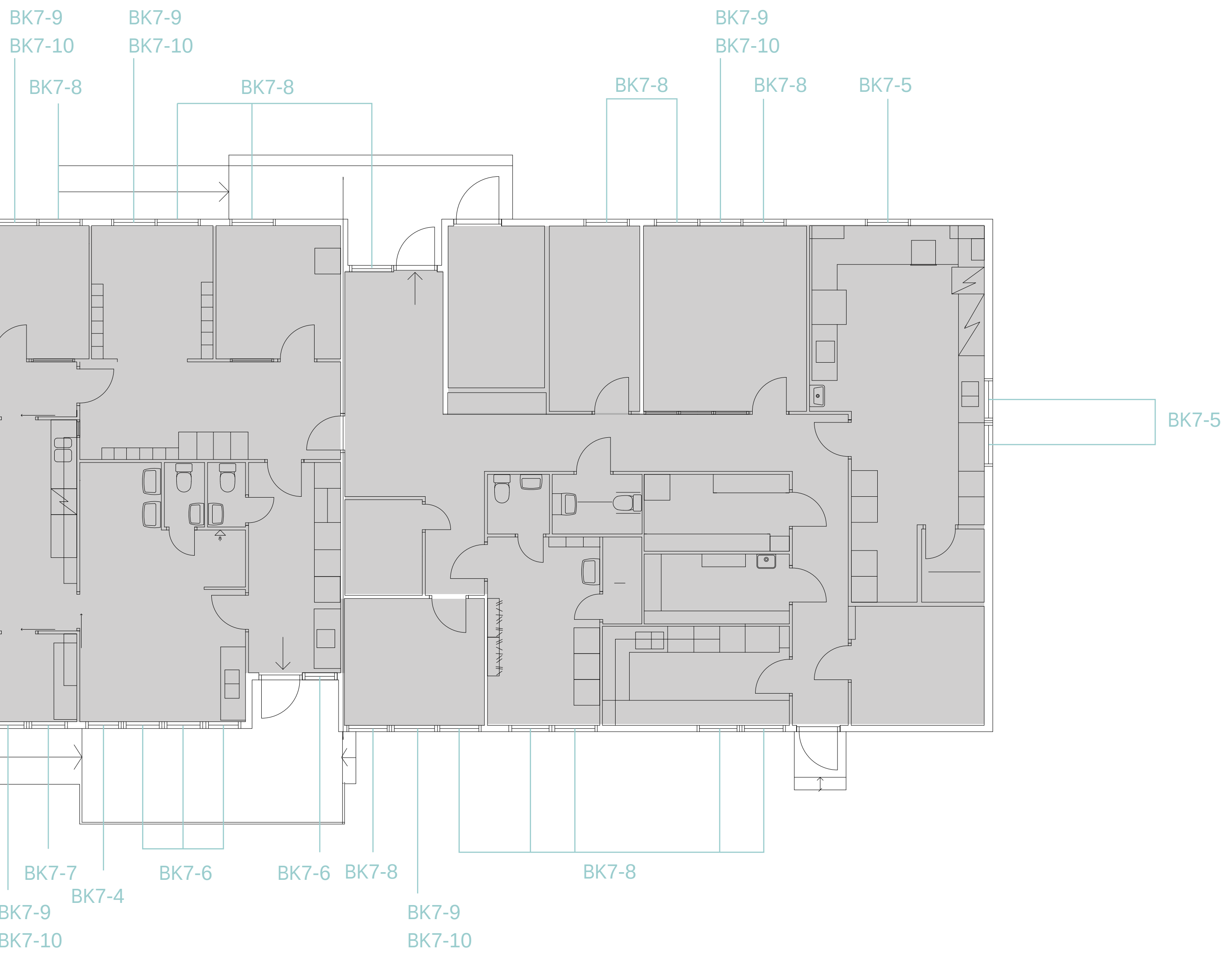
BUILDING OVERVIEW



2 . BACKA KYRKOGATA 7

FLOORPLAN





Plaster Acoustic Panel

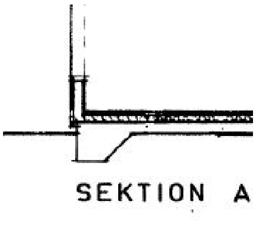
Scale = 1/150

2 . BACKA KYRKOGATA 7

PHOTO REGISTRATION

BK7-1 *Concrete Roof Tile*

BK7-2 *Concrete Slab*



BK7-3 *Concrete Block*

BK7-4 *Glass*

BK7-5 *Glass*

BK7-6 *Glass*

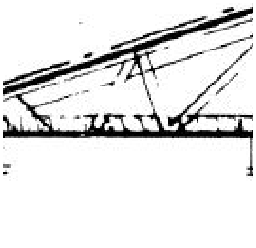
BK7-7 *Glass*

BK7-8 *Glass*

BK7-9 *Glass*

BK7-10 *Glass*

BK7-11 *Insulation*



BK7-12 *Acoustic Panel*

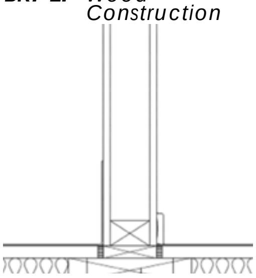
BK7-13 *Steel Grating*

BK7-14 *Steel Drainage*

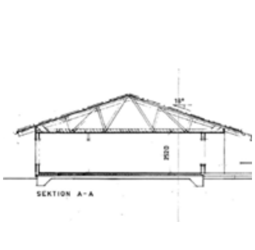
BK7-15 *Vinyl/Linoleum Floor*

BK7-16 *Wood Cladding*

BK7-17 *Wood Construction*



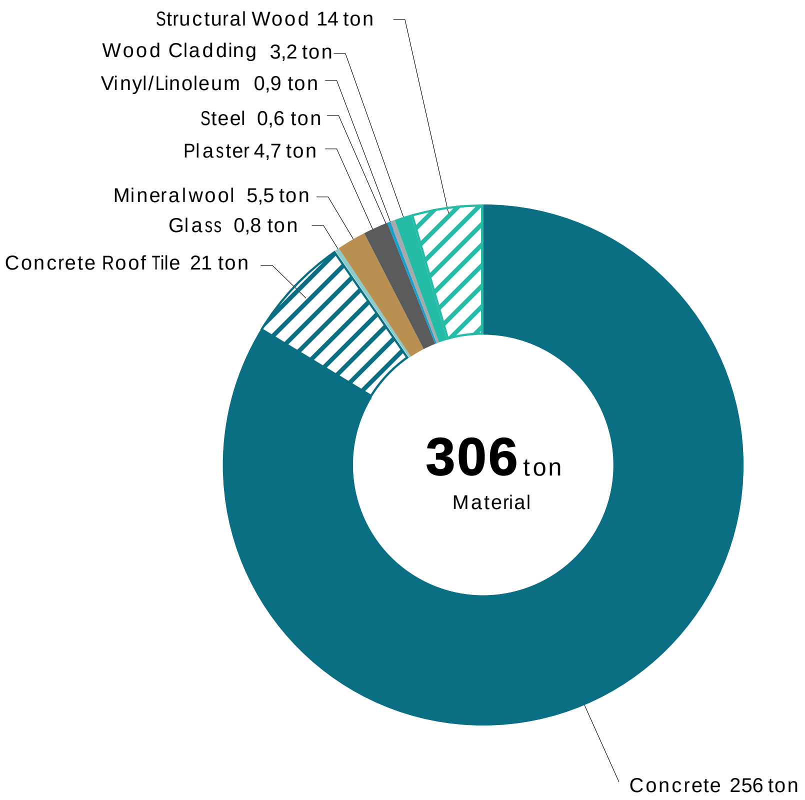
BK7-18 *Wood Beam*



BK7-19 *Window Frame*

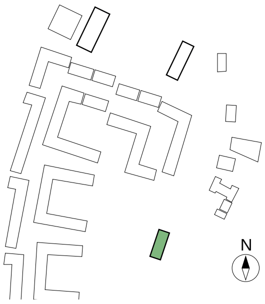
BK7-20 *Skirting Board*

MATERIAL AMOUNTS



3 . BACKA KYRKOGATA 9

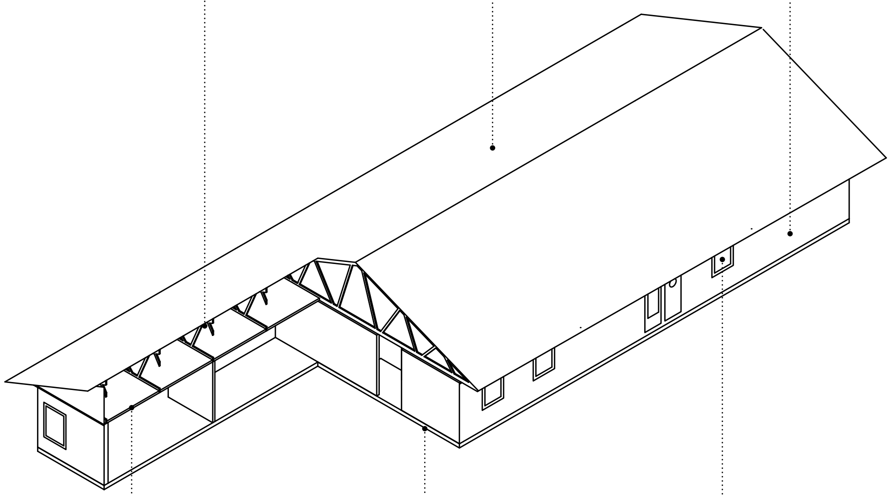
Address: Backa Kyrkogata 9, 422 58 Hisings Backa, Sweden
Construction Year: 1971
Total Area: 396 sqm
Structure: Wood



Material List

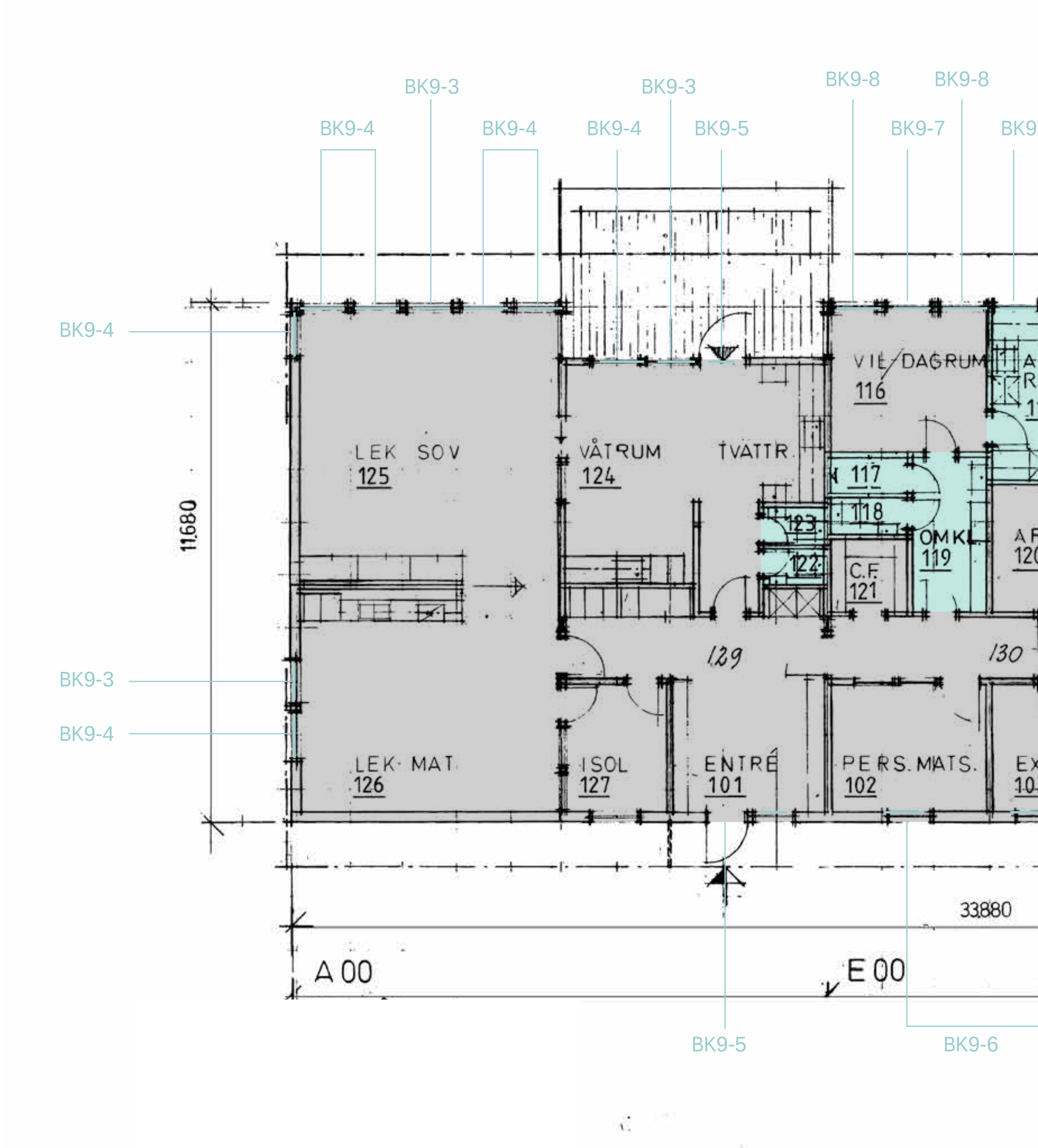
ID	Material	Element	Stk	Amount	Unit	Reuse	Upcycle	Downcycle
BK9-1	Concrete	Roof tile	-	520	m2	✓		
BK9-2	Concrete	Slab	-	396	m2		✓	
BK9-3	Glass	2-glazing window	13	18,72	m2		✓	
BK9-4	Glass	2-glazing window	1	1,152	m2		✓	
BK9-5	Glass	2-glazing window	5	3,75	m2		✓	
BK9-6	Glass	2-glazing window	3	1,65	m2		✓	
BK9-7	Glass	2-glazing window	3	2,85	m2		✓	
BK9-8	Glass	2-glazing window	4	3,16	m2		✓	
BK9-9	Glass	2-glazing window	6	6,6	m2		✓	
BK9-10	Mineralwool	Insulation	-	69,86	m3	✓		
BK9-11	Plaster	Acoustic panel	-	321	m2	✓		
BK9-12	Steel	Drainage	-	0,12	ton	✓		
BK9-13	Vinyl/Linoleum	Floor	-	396	m2			✓
BK9-14	Wood	Cladding	-	236	m2	✓		
BK9-15	Wood	Construction	-	11,22	m3	✓		
BK9-16	Wood	Skirting board	-	89	m	✓		
BK9-17	Wood	Particle board	-	0,5	m3	✓		
BK9-18	Wood	Roof truss	-	4,23	m3	✓		
BK9-19	Wood	Window frame	-	111	m	✓		

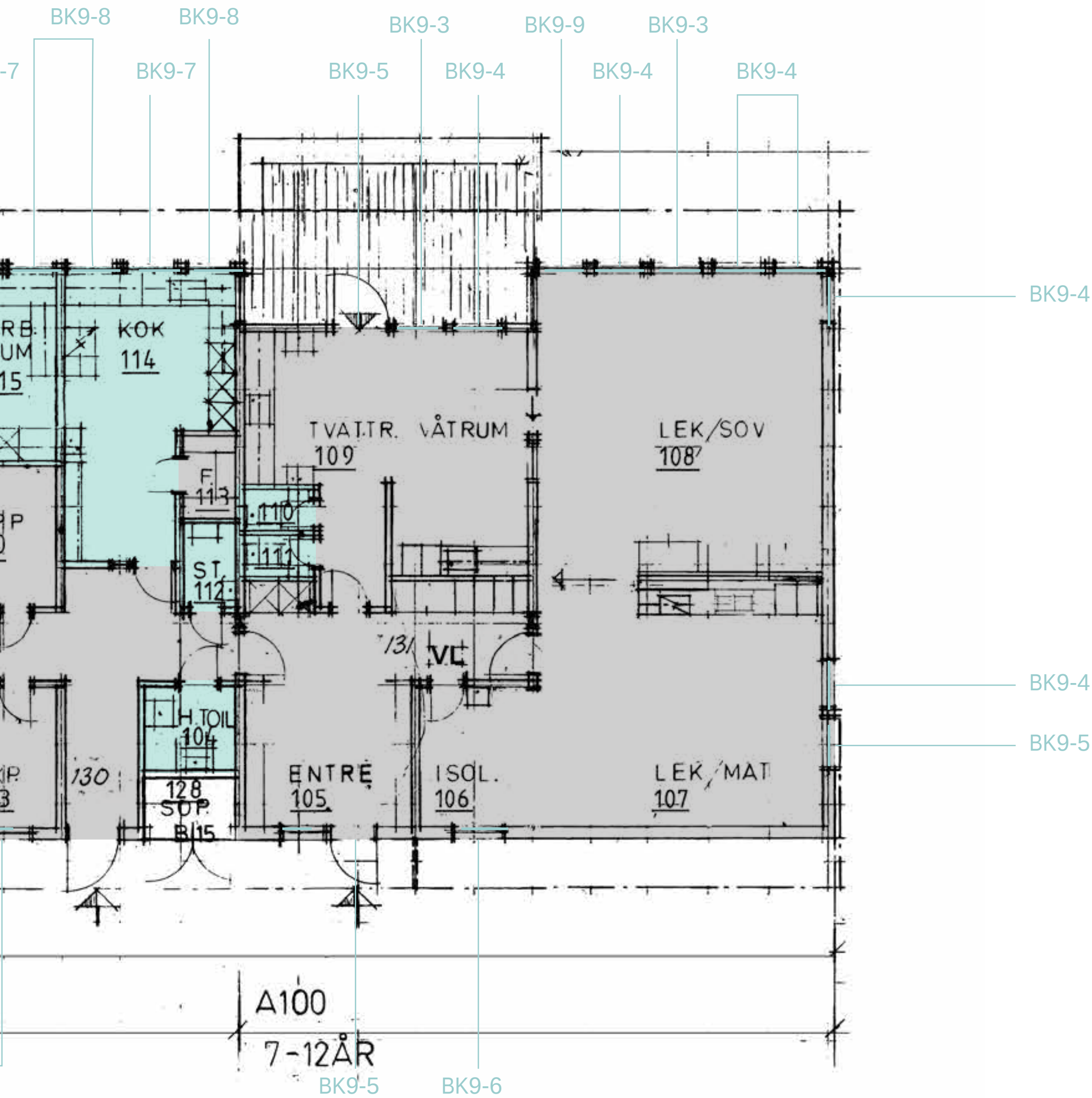
BUILDING OVERVIEW



3 . BACKA KYRKOGATA 9

FLOORPLAN





Mineral wool

Plaster Acoustic Panel

Plywood

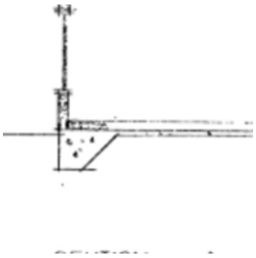
Scale = 1/150

3 . BACKA KYRKOGATA 9

PHOTO REGISTRATION

BK9-1 *Concrete Roof Tile*

BK9-2 *Concrete Slab*



BK9-3 *Glass*

BK9-4 *Glass*

BK9-5 *Glass*

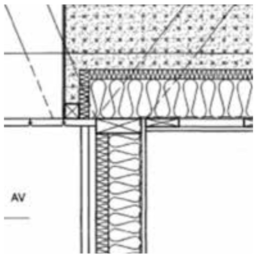
BK9-6 *Glass*

BK9-7 *Glass*

BK9-8 *Glass*

BK9-9 *Glass*

BK9-10 *Insulation*



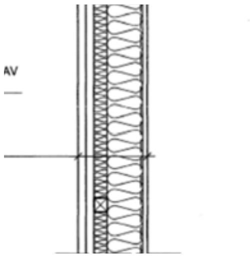
BK9-11 *Acoustic Panel*

BK9-12 *Steel Drainage*

BK9-13 *Vinyl/Linoleum Floor*

BK9-14 *Wood Cladding*

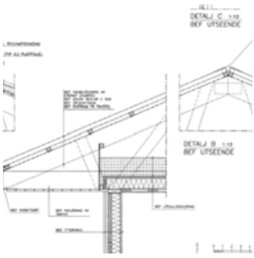
BK9-15 *Wood Construction*



BK9-16 *Skirting Board*

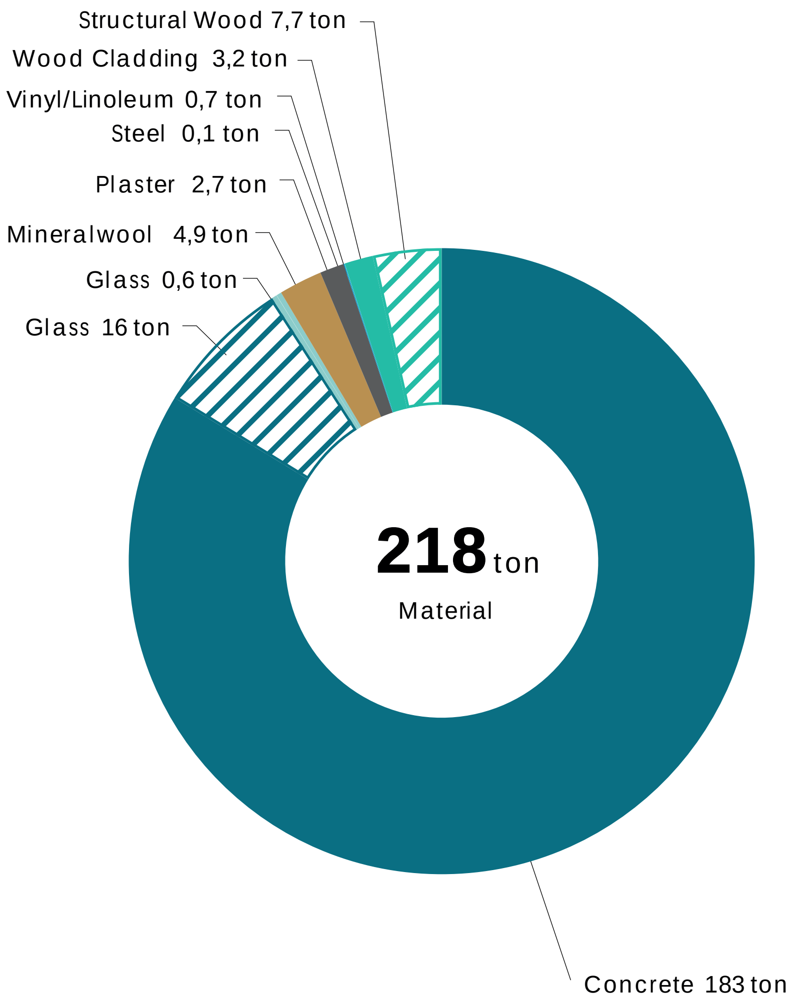
BK9-17 *Plywood*

BK9-18 *Wood Beam*



BK9-19 *Window Frame*

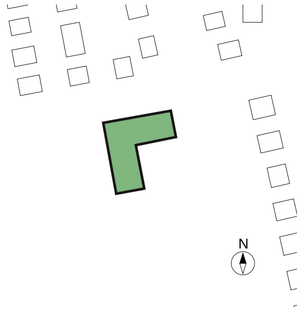
MATERIAL AMOUNTS



4 . BISKOPSGATAN 8

MATERIAL OVERVIEW

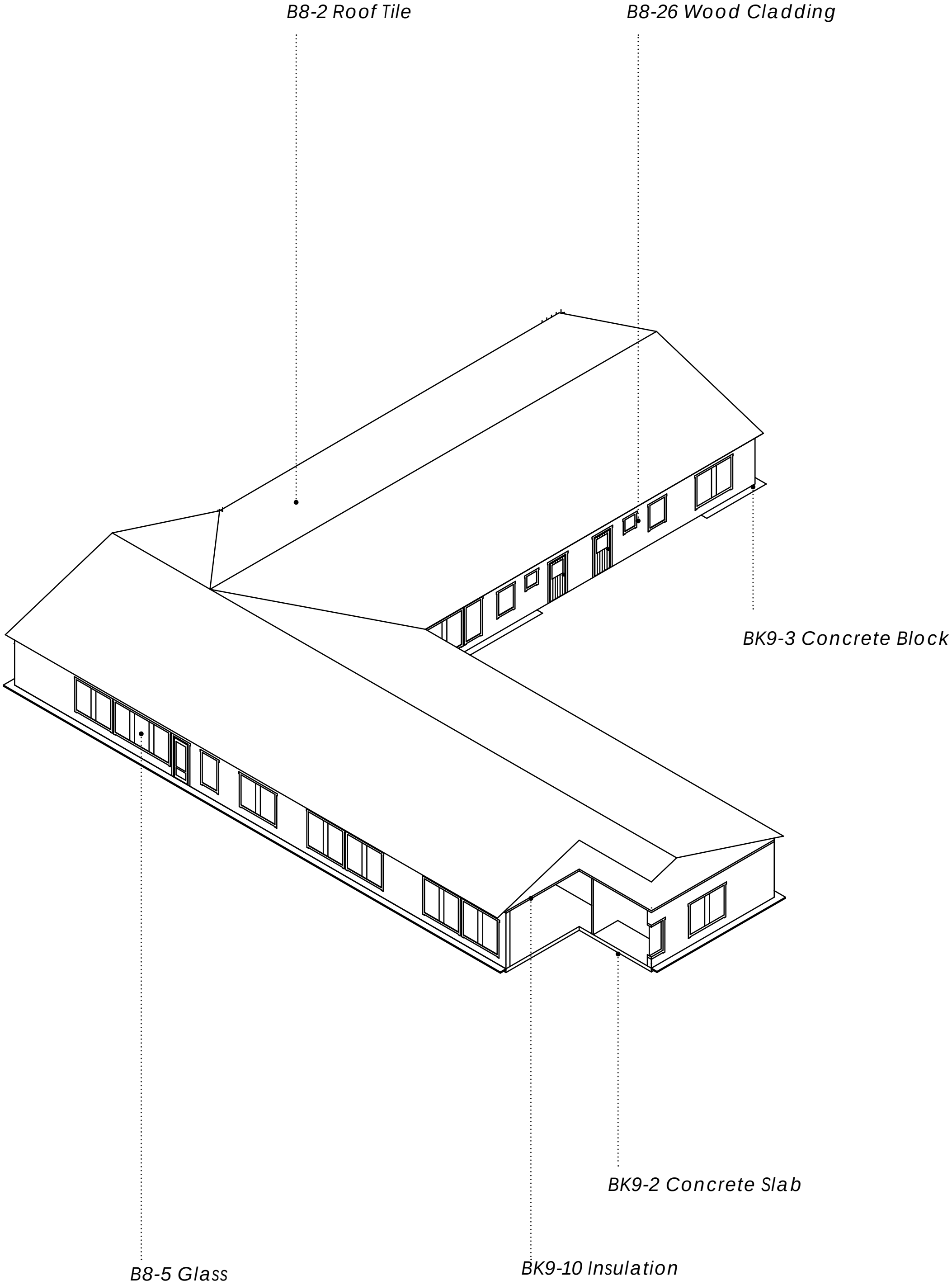
Address: Biskopsgatan 8, 418 77 Göteborg, Sweden
Construction Year: 2013
Total Area: 687 sqm
Structure: Wood



Material List

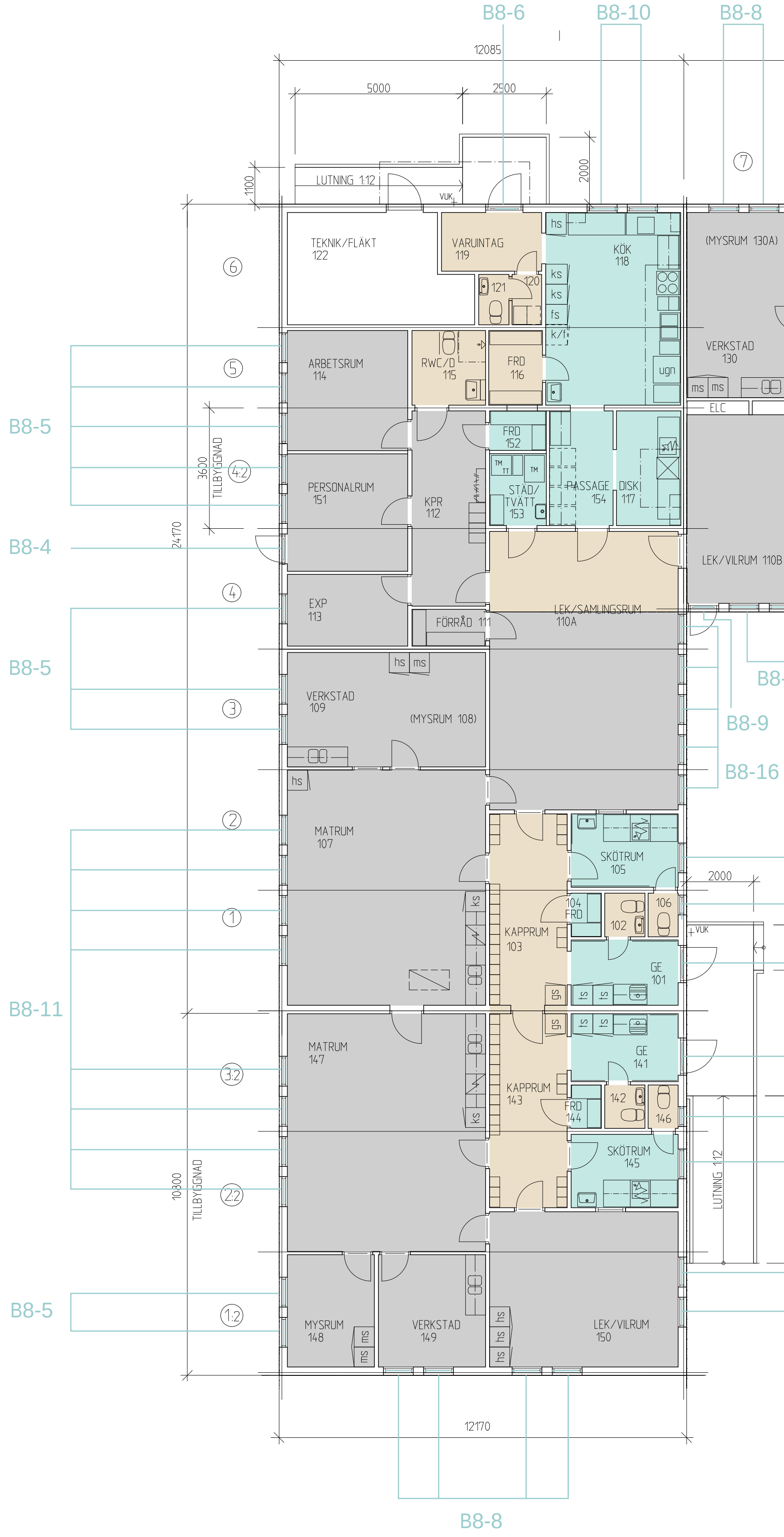
ID	Material	Element	Stk	Amount	Unit	Reuse	Upcycle	Downcycle
B8-1	Concrete	Slab	-	689	m2		✓	
B8-2	Concrete	Roof tile	-	771	m2	✓		
B8-3	Concrete	Pavementblock	-	38	m2		✓	
B8-4	Glass	3-glazing window	1	0,78	m2		✓	
B8-5	Glass	3-glazing window	10	12	m2		✓	
B8-6	Glass	3-glazing window	3	1,5	m2		✓	
B8-7	Glass	3-glazing window	2	1	m2		✓	
B8-8	Glass	3-glazing window	14	16,8	m2		✓	
B8-9	Glass	3-glazing window	1	0,95	m2		✓	
B8-10	Glass	3-glazing window	2	1,44	m2		✓	
B8-11	Glass	3-glazing window	19	25,84	m2		✓	
B8-12	Glass	3-glazing window	2	1,76	m2		✓	
B8-13	Glass	3-glazing window	1	0,26	m2		✓	
B8-14	Glass	3-glazing window	1	0,25	m2		✓	
B8-15	Glass	3-glazing window	2	1,76	m2		✓	
B8-16	Glass	3-glazing window	6	8,22	m2		✓	
B8-17	Glass	3-glazing window	1	0,26	m2		✓	
B8-18	Glass	3-glazing window	1	1,36	m2		✓	
B8-19	Glass	3-glazing window	1	0,26	m2		✓	
B8-20	Mineralwool	Acoustic panel	-	90	m2	✓		
B8-21	Mineralwool	Insulation	-	99,68	m3	✓		
B8-22	Plaster	Acoustic panel	-	406	m2	✓		
B8-23	Steel	Grating	8	0,42	ton	✓		
B8-24	Steel	Drainage	-	0,26	ton	✓		
B8-25	Vinyl/Linoleum	Floor	-	689	m2			✓
B8-26	Wood	Cladding	-	306	m2	✓		
B8-27	Wood	Construction	-	20,09	m3	✓		
B8-28	Wood	Skirting board	-	304	m	✓		
B8-29	Wood	Particle board	-	1,06	m3	✓		
B8-30	Wood	Window frame	-	257	m	✓		
B8-31	Wood	Roof truss	-	11	m3	✓		

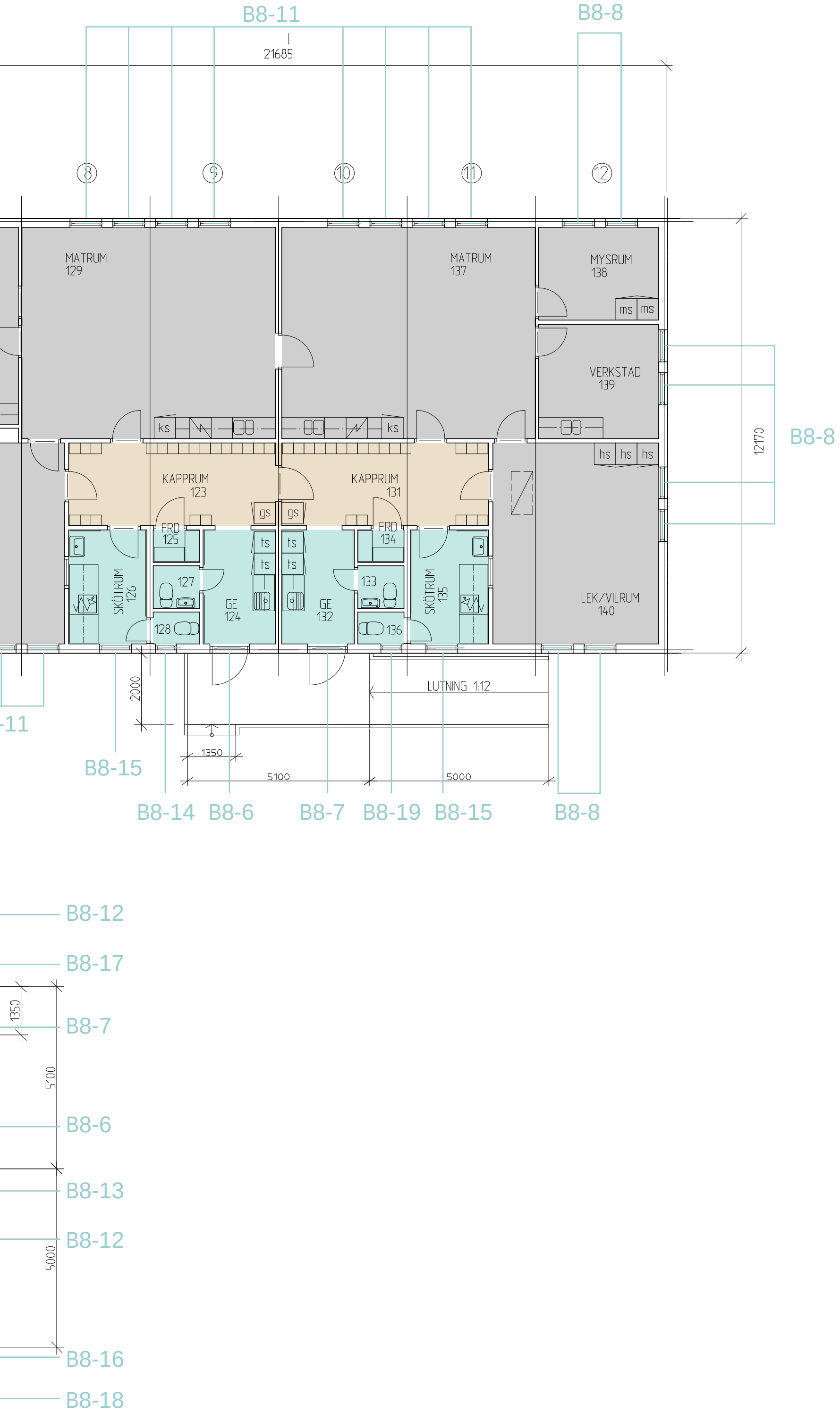
BUILDING OVERVIEW



4 . BISKOPSGATAN 8

FLOORPLAN





Mineral wool

Plaster Acoustic Panel

Plywood

Scale = 1/200

4 . BISKOPSGATAN 8

PHOTO REGISTRATION

B8-1 *Concrete Slab*

B8-2 *Concrete Roof*

B8-3 *Concrete Block*

B8-4 *Glass*

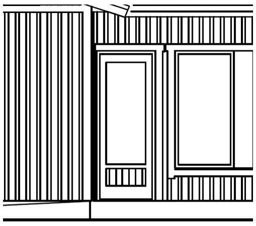
B8-5 *Glass*

B8-6 *Glass*

B8-7 *Glass*

B8-8 *Glass*

B8-9 *Glass*



B8-10 *Glass*

B8-11 *Glass*

B8-12 *Glass*

B8-13 *Glass*

B8-14 *Glass*

B8-15 *Glass*

B8-16 *Glass*

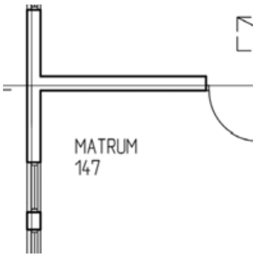
B8-17 *Glass*

B8-18 *Glass*

B8-19 *Glass*

B8-20 *Mineral Wool*

B8-21 *Insulation*



B8-22 *Acoustic Panel*

B8-23 *Steel Grating*

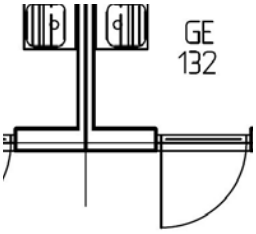
B8-24 *Drainage*

B8-25 *Vinyl/Linoleum Floor*

MATERIAL AMOUNTS

B8-26 *Wood Cladding*

B8-27 *Wood Construction*

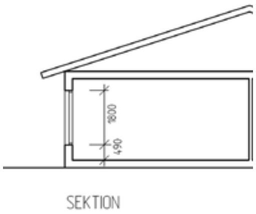


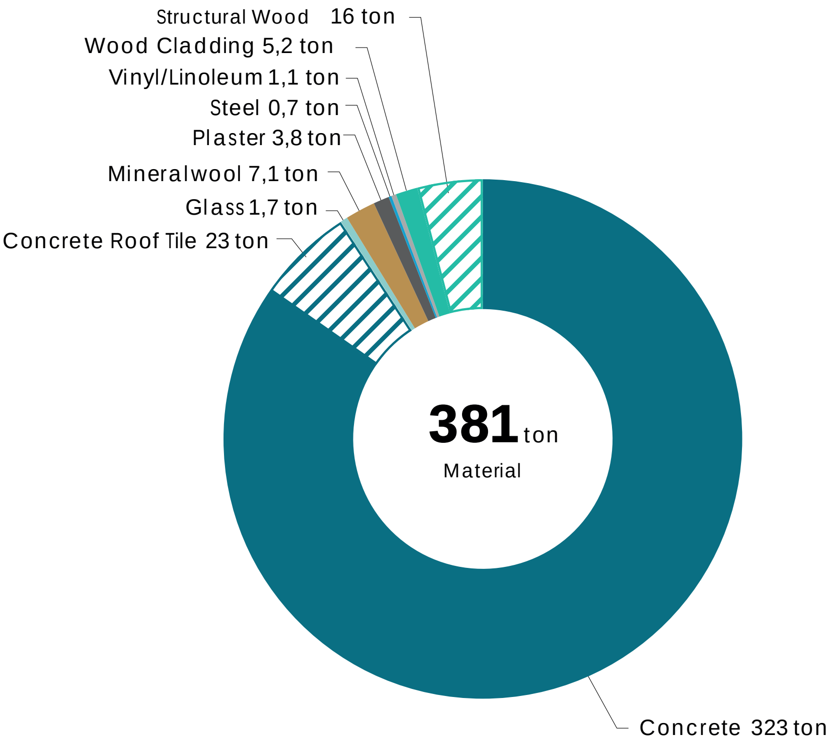
B8-28 *Skirting Board*

B8-29 *Plywood*

B8-30 *Window Frame*

B8-31 *Wood Beam*





CHAPTER 3
HOPPET RESOURCE BANK

POTENTIALS ACROSS BUILDINGS

POTENTIALS ACROSS BUILDINGS

In this chapter, the potential for circulation across the mapped buildings is quantified. Here, it is possible to get an overview of:

1. The type and amount of materials
2. Overall and material specific potential of CO_2 savings through circulation. The potentials are calculated based on the total quantity of each material category and as a CO_2 per material unit (m^2 / m^3).
3. The amount of new building materials that can be produced based on the mapped resources.

THE TOTAL QUANTITIES

On this page we show the total amount of mapped materials and the units used. The pie chart shows the representation of all materials in ton.

When calculated in ton, concrete makes up as much as 1064 ton. Besides the concrete, we see a large amount of concrete roof tiles, structural wood, mineral wool and wood cladding. All these materials are very classic to Swedish construction.

We see a similar picture when materials are calculated in their respective fitting units. Again concrete roof tile, wood cladding and wood structures stand out but now supplemented by a large amount of mostly plaster and vinyl/linoleum.

As the four buildings mapped are relatively small in total square meter, we recommend that a circulation of materials is done through prioritisation of highest potential materials and supplemented with materials from other locations. Alternatively we acknowledge that it can be difficult to make a balanced business case. This does not necesarily include the concrete roof tile and wood as the amounts here can be high enough to cover a specific need in a new construction.

SUMMARY OF MATERIALS FOR HOPPET:

Asfalt Roofing	657	m2
Concrete Roof Tile[1]	1.974	m2
Concrete[2]	460	m3
Glass	251	m2
Mineralwool	365	m3
Plaster	1.544	m2
Plastic Roof	241	m2
Steel	1,5	ton
Vinyl/Linoleum	2.292	m2
Wood Cladding[3]	1.583	m2
Structural Wood[4]	95	m3

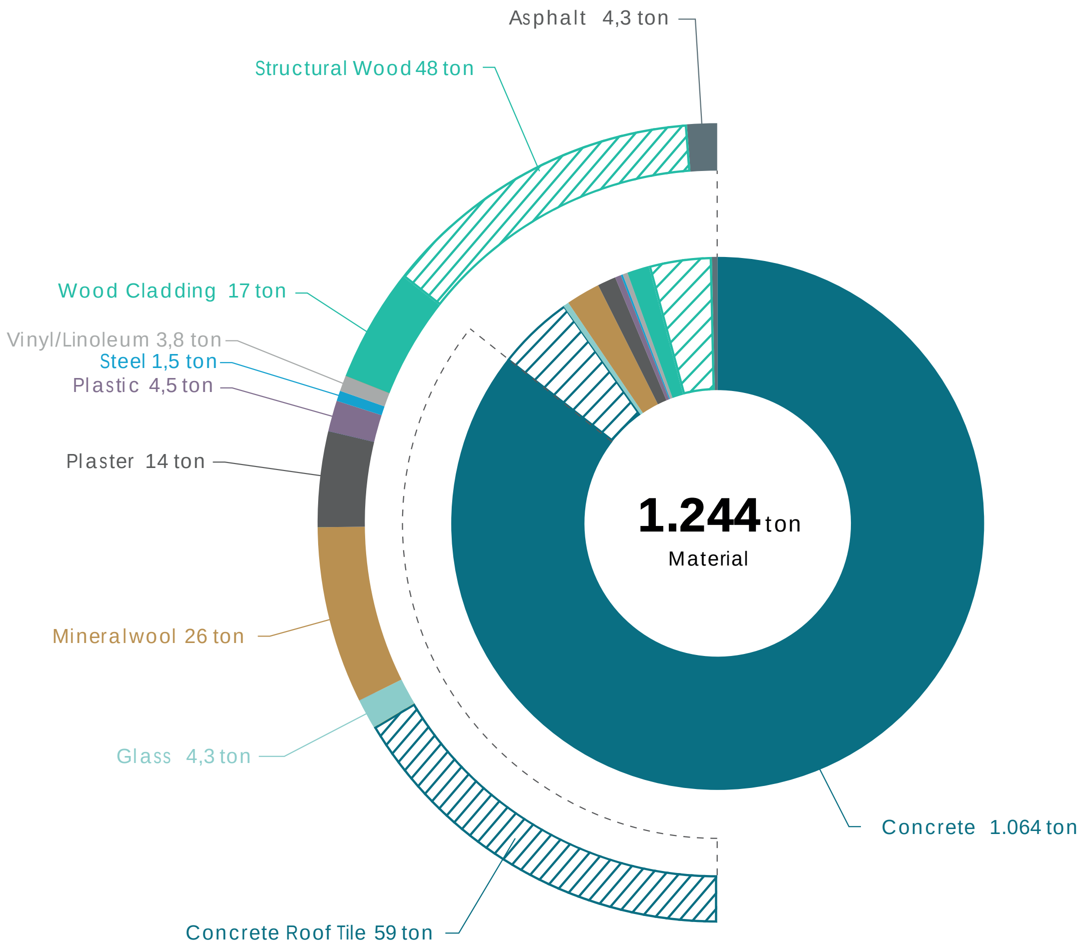
1. Direct reuse of concrete roof tile

2. Existing concrete slabs and pavements

3. Including wood cladding, particle board, skirting board and window frame

4. Including all construction wood inside walls and truss structure under the roof. The amount of wood beams in wood was estimated based on the grid found in floor drawings.

TOTAL AMOUNT OF MATERIALS IN TON



POTENTIALS FOR CO_2 SAVINGS

POTENTIALS FOR CO_2 SAVINGS

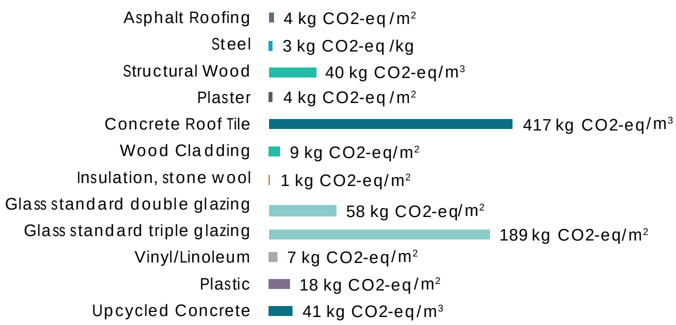
When determining the impact of resource optimisation through material circulation it is important to look at the different materials' CO_2 footprint. This guides the choice of materials for circulation and promotes greater potential for CO_2 savings.

The following section provides an insight into the potential CO_{2}. savings by reusing each material category in the mapped buildings. The potential for CO_2 savings is based on what it will cost in CO_2eq to produce the equivalent virgin materials.

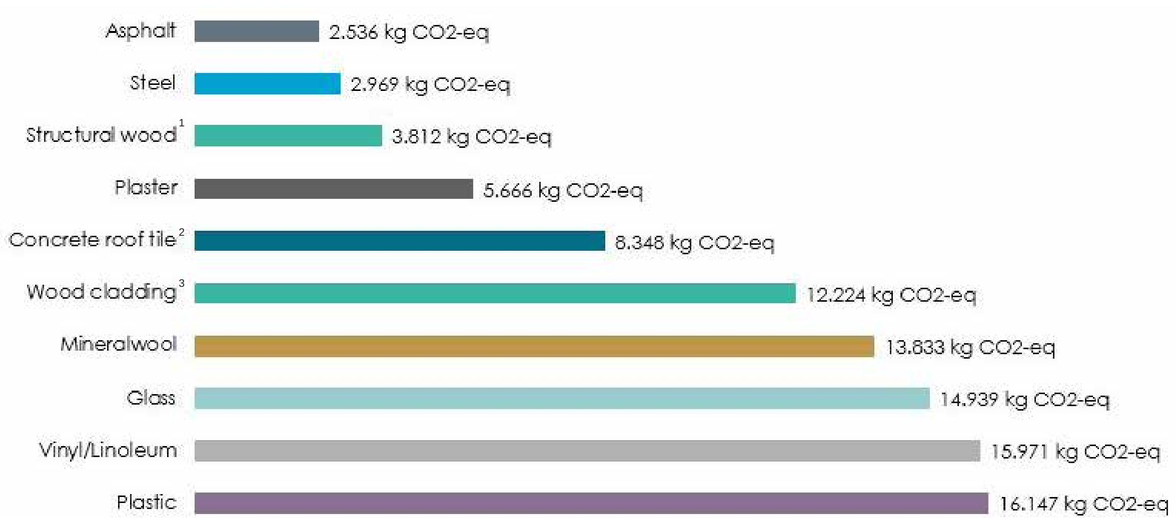
The CO_2 calculations are based on EPD's where the production phases A1-A3 are assumed to be equal to the amount of CO_2 you can save through direct reuse.

The following pages show the numbers for CO_2 savings per material unit and across amounts mapped in the four building.

POTENTIAL CO_2 SAVINGS PER UNIT



POTENTIAL CO_2 SAVINGS BY DIRECTLY REUSING THE MAPPED MATERIALS AT HOPPET



1. Including estimated amount of construction wood inside wall and truss structure under the roof
2. Direct reuse of concrete roof tile
3. Includes wood cladding, particle board, skirting board and window frame

POTENTIAL CO_2 SAVINGS BY REUSING THE MAPPED CONCRETE AT HOPPET

4. Existing concrete slabs and pavements crushed as aggregate for new concrete

CO_2 IN RELATION TO TYPE AND AMOUNT

When materials are selected for circulation it is important to look at the relation between CO_2 embedded per unit and the total amount of CO_2 embedded in full material amount for Hoppet.

In terms of CO_2 per unit especially concrete roof tile, tripple and double glazing glass and structural wood stand out. If we look at potential CO_2 savings based on the amounts mapped we see a different picture. Here upcycled concrete has the highest potential followed by plastics, vinyl/linoleum and glass.

Though concrete initially seems to be the material with highest potential, we expect that it will be difficult to circulate as it is likely to be contaminated with soil, since most concrete is to be found in the foundation of the buildings.

CO_2 AND RESOURCE CONSUMPTION

The overall potential for CO_2 savings can seem low compared to other projects. This is mainly due to the large amounts of wood in the area. This is an aspect that underlines the importance of looking beyond CO_2 calculations and savings when aiming for sustainable development. The emission of CO_2 per unit is rather low for wood making the overall potential of CO_2 saving lower. However, we must not undermine the importance of reusing wood since there is a lot to be saved in regards to resource consumption and production of virgin materials. As wood literally is a CO_2 bank there is no need to put additional pressure on an already stretched industry.

REUSE VS. RECYCLE

In addition to material type and amount, the process for circulation is also an important factor to potential CO_2-saving. The more directly a material is circulated, the more CO_2 you can save. This is due to CO_2 emitted during the treatment process. We normally recommend to reuse concrete elements directly, but as most concrete for Hoppet is mapped as foundational concrete, we foresee that this is not a viable solution.

POTENTIAL CO_2 SAVINGS IN TOTAL

Total CO_2 savings

281.174 kg CO_2-eq

by directly reusing all the materials

Total CO_2 savings

124.723 kg CO_2-eq

by directly reusing all the materials except concrete which will be reused as aggregate in new concrete

281.174 kg CO_2-eq
can potentially be saved by directly reusing all the materials which corresponds to

66 avg Swedes
annual CO_2 emission

or

100 car owners
taking their bike for an entire year

NEW CIRCULATED MATERIALS

AMOUNT OF NEW CIRCULATED BUILDING MATERIALS

Below you find a qualification of the amount of new circulated building materials that can be produced based on the mapped materials for Hoppet.

The amounts are based on Lendager UP's extensive experience in circulating different types of materials.

In these calculations structural wood and wood cladding is combined in one category circulated as wood cladding.

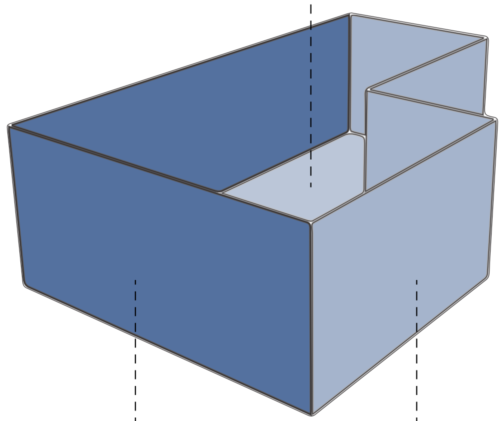
REFERENCE HOUSES

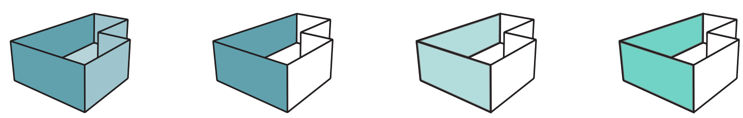
Based on the amount of materials we have conducted a calculation of the amount of reference houses that can be built with Lendager UP products based on materials from Hoppet.

Below you find a description of the baseline of the calculation of number of reference houses in terms of type of material across structure and cladding.

On the next page you find how wood and concrete roof tiles, again, stand out in their amounts. Here both materials are circulated as facade elements.

REFERENCE HOUSE





THE AMOUNT OF MAPPED MATERIALS VS. THE AMOUNT OF LENDAGER UP PRODUCTS

Circulation percentage for Lendager UP products

UP Concrete	45 %
UP Roof Tile Facade	85 %
UP Wood Facade	98-100 %
UP Window	85 %

Material amount in Hoppet

Concrete	460 m³
Roof Tile	1974 m²
Wood*	6.366 m²
Window	251 m²

→

Material amount after circulation

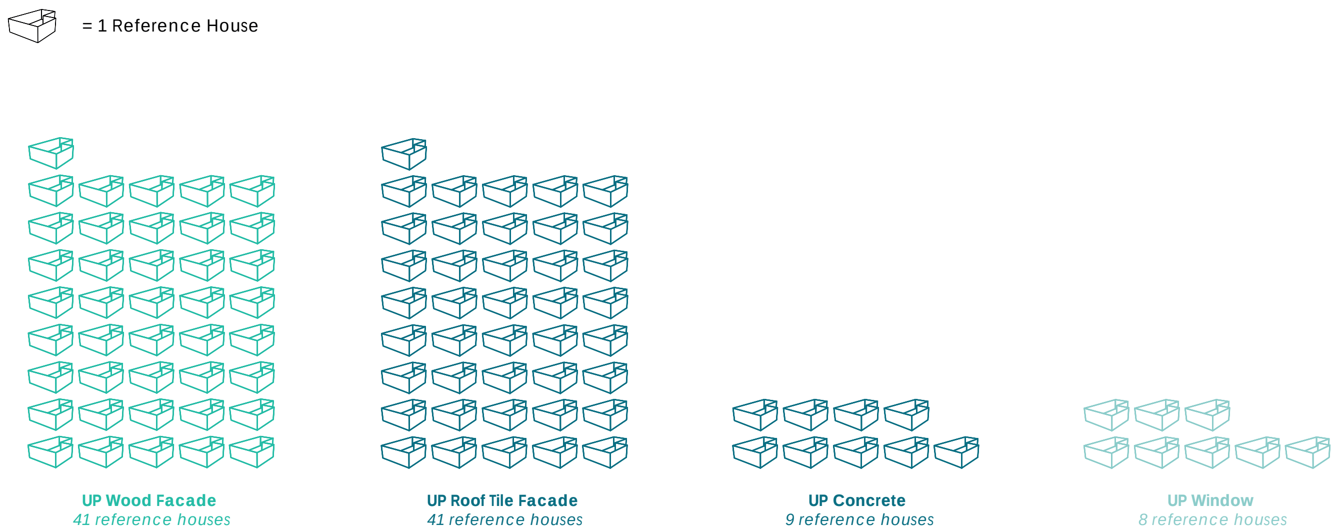
UP Concrete	690 m³
UP Roof Tile Facade	2.322 m²
UP Wood Facade*	6.366 m²
UP Window	184 m²

** The area of wood in this calculation relies on the assumption that all types of wood are sliced in 2 cm thick boards*

REFERENCE HOUSES WITH LENDAGER UP PRODUCTS

The reference house is a 4 person apartments based on the following assumptions:

- Area: 100 m²
- Height: 4 m
- Raw house: Concrete
- Half of the apartments perimeter is climate screen with 30% window area




BRANDLARM
LENDAGER GROUP

POTENTIALS ACROSS BUILDINGS

CENTRAL POTENTIALS AND CONCLUSIONS

Total amount of materials mapped for Hoppet is 1.244 tons of building materials, all currently standing as four buildings used as children institutions.

As the buildings separately are relatively small, it is of high value that the materials have been mapped together as this brings a quantity of specific materials that eases the circulation process in terms of design, supply/demand and economic expenses.

Based on the materials mapped two categories of material circulation are formed:

1. A category of materials that should be reused or upcycled due to their embedded CO_2, quantity and quality (including structural wood, wood cladding, concrete roof tiles and glass).

2. Another category of materials where we recommend to find a local expert in recycling the materials through a downcycling process (including concrete, plastic, vinyl/linoleum and mineral wool).

For the upcycling category, the wood can become beautiful wall cladding both inside and outside, glass can become new well-performing windows or glass aggregate and concrete roof tiles can become nice facades or aggregate for new concrete.

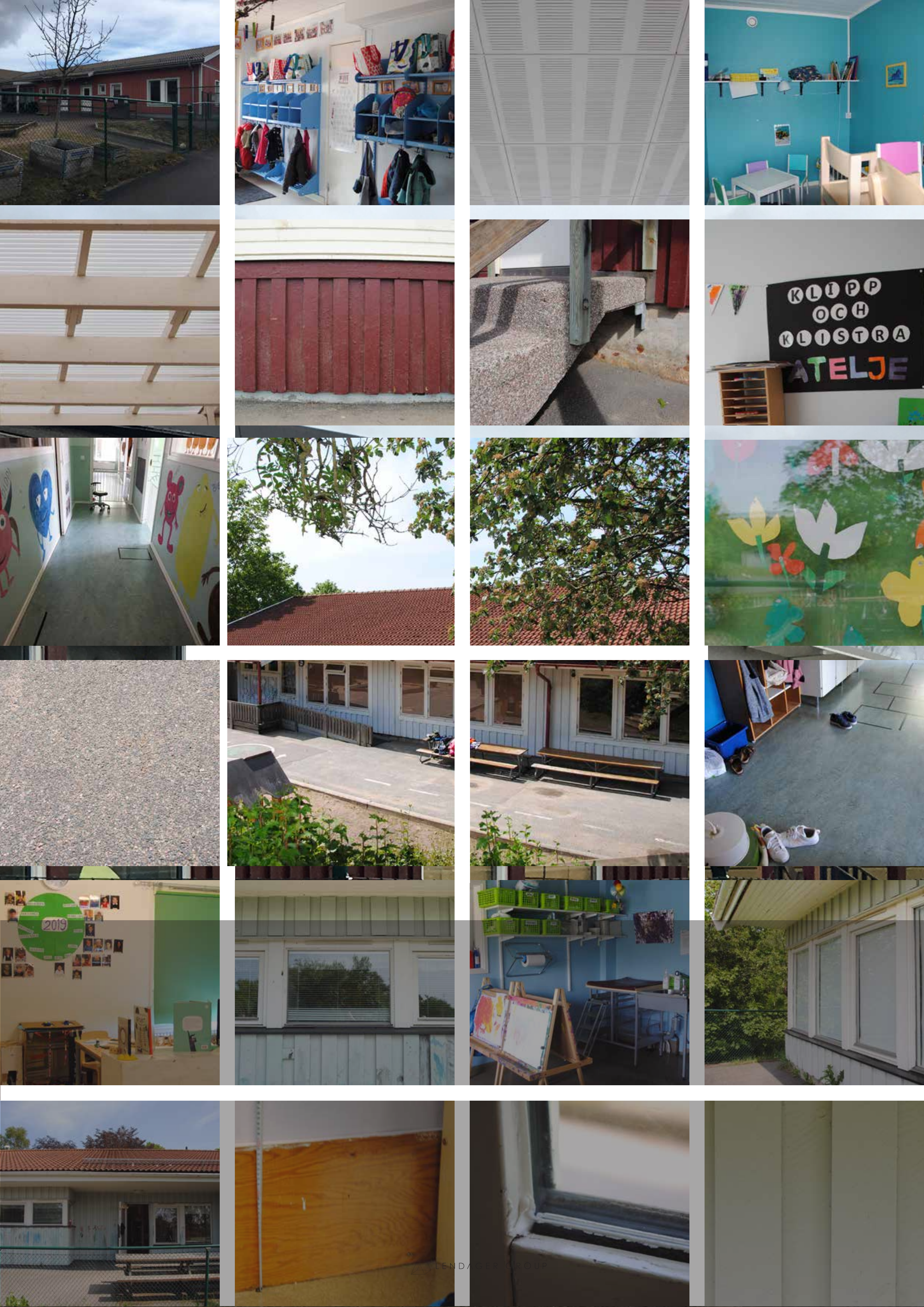
So far we have managed to map the available resources from the four buildings. Based on the results, we know the quantities, quality and pollution mitigation potential, which has been used to assess the different materials' circulation potentials. The following phase will be investigating the materials' circulation potential as new materials and building components.

CENTRAL CONCLUSIONS

1 INTERESTING AMOUNT FOR DIRECT REUSE OR UPCYCLING OF THE MATERIALS; CONCRETE ROOF TILES, STRUCTURAL WOOD AND WOOD CLADDING.

2 THE MATERIALS CONCRETE, PLASTIC, VINYL/LINOLEUM AND MINERAL WOOL SHOULD BE GIVEN TO A RECYCLING STATION OR PRODUCER WHO CAN ASSURE RECYCLING OF MATERIALS, AIMING FOR HIGHEST POSSIBLE VALUE.

3 DUE TO TOTAL AMOUNTS OF MATERIALS MAPPED, WE SUGGEST CONSIDERING SUPPLEMENTING THEM WITH MATERIALS FROM OTHER BUILDINGS READY FOR RENOVATION/DEMOLITION, IN ORDER TO ENSURE A QUALITY THAT ENABLES THE BUSINESS CASE AND COVERS THE MATERIAL NEEDS IN NEW CONSTRUCTION PROJECTS.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CHAPTER 4
IDEA CATALOGUE

IDEAS

RESOURCES WITH OPPORTUNITIES

It is one thing to know the resources available as clarified in chapter 2 and 3. It is another to understand how the materials can be circulated and into what.

The purpose of the idea catalogue is to give an insight to the many opportunities that exist in circulating the demolished building materials for the new project. The idea catalogue casts light on the value of the different materials. It does so because it is good business, because it will give the project a unique character and because it reduces CO_2 emissions and resource consumption.

20 IDEAS

In the following chapter we present 20 ideas for circulation of selected mapped materials for Hoppet. The ideas are separated in the following three categories:

1. Structural wood
2. Wood cladding
3. Concrete roof tiles

All ideas are presented with the following:

- Total amount of output materials,
- Potential CO_2 savings,
- How to treat the material,
- How far the idea has already been developed,
- How much of the finished product is based on circulated materials (in percentage),
- A description of the material and process,
- Reference pictures of the idea,
- Diagram of the circulation process and result.

UNCERTAINTY MARGIN

When reading through the potential output amounts within each idea it is important to account for a 20 % uncertainty margin as there are several unknown factors impacting final amounts including purity, state after harvesting and need for further development of several ideas.

GLOSSARY

In the end of this chapter, all ideas presented are summarized in the categories *exterior*, *interior*, *landscape* and *construction* to give a fast overview of the different applications of the ideas.

METHODS FOR CIRCULATION

Ideas for the circulation of each material category spread across three different methods to process the specific materials; clean, cut, crush. These methods are essential in the idea development stage and determine the value of the final circulated materials. It is highly recommended to always aim to minimize processing of materials, as it will impact future value. The objective should therefore be to minimize both financially and resource-demanding processes.

CLEAN

The materials are processed as little as possible through, for example, grinding, sandblasting or cleaning of nails and other light pollutions.

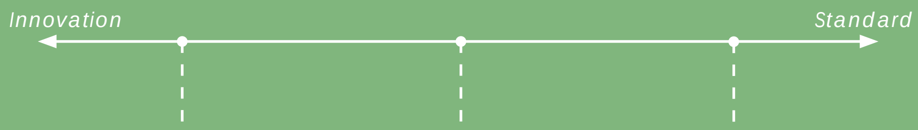
CUT

The materials are cut so that the size and shape is adjusted to the desired design and purpose.

CRUSH

The materials are crushed and put together with new building materials, sometimes through the application of virgin materials.

STAGES OF DEVELOPMENT



IDEA

A new solution that has to be developed and tested substantially in order to be implemented in a building

CONCEPT

The solution requires less development work and is partially proven through similar solution / mock-ups.

PRODUCT

The solution is developed and used in other buildings.

The ideas presented in the idea catalogue are at very different stages of development. Some will require a real innovation process to be carried out while others are fully developed and finished products. When assessing and subsequently selecting any ideas, it is important to consider development efforts in terms of material properties, additional costs and time needed for the development process. Therefore, all ideas presented here are marked as either idea, concept or product. In this way, priorities can be made and risks assessed in terms of volumes and performance.

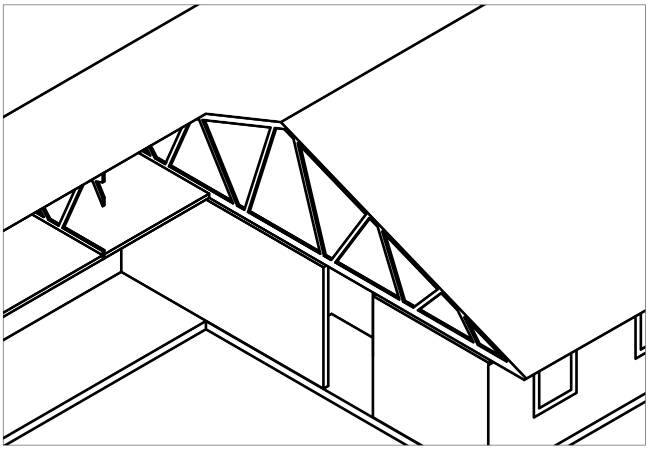
1. STRUCTURAL WOOD

A large amount of structural wood has been mapped in the existing buildings. This includes especially structural wood and wood trusses.

Considering these amounts of wood and the fact that Göteborg Stad has a desire to use wood as a building material, they can convey the existing kindergardens identity through circulation of the already existing structural wood.

For every cubic meter of wood used as a substitute of another building material, the CO_2 emission can be reduced by an average of 1.1 ton. Our houses are full of wood. By circulating already existing structural wood, we can save large amounts of CO_2 emission and avoid using the Earth's already stressed resources.

Structural wood



Wood Trusses

	Backa Kyrkogata 3	*Backa Kyrkogata 7*	*Backa Kyrkogata 9*	*Biskops-gatan 8*	*Total*
Struc. wood	16,0 m^3	15,7 m^3	11,2 m^3	20,1 m^3	63,0 m^3
Roof trusses	5,3 m^3	11,7 m^3	4,2 m^3	11,1 m^3	32,3 m^3
TOTAL	**21,3 m^3**	**27,4 m^3**	**15,5 m^3**	**31,2 m^3**	**95,3 m^3**

CLEAN

- *Reuse* → 1.1 **ROOF CONSTRUCTION**
  Wood trusses are reused directly
- *Reuse* → 1.2 **PAVILION**
  The wood is used for outdoor pavilions
- *Reuse* → 1.3 **LANDSCAPE ELEMENTS**
  The wood is used for outdoor installations

CUT

- *Upcycle* → 1.4 **FURNITURE**
  The wood is cut into urban furniture
- *Upcycle* → 1.5 **END GRAIN FLOORING**
  The wood is cut into blocks for new flooring
- *Upcycle* → 1.6 **SUN SHADING**
  The wood is cut into vertical sunbeams
- *Upcycle* → 1.7 **ACOUSTIC PANELS**
  The wood is assembled to panels

CRUSH

- *Downcycle* → 1.8 **INSULATION**
  The wood is crushed to fibres
- *Downcycle* → 1.9 **OSB**
  The wood is crushed and pressed together
- *Downcycle* → 1.10 **WOOD CHIPS**
  The wood is crushed to chips

Eco Nursery - Jean-François Schmit

Roof construction - Trusswalk

ROOF CONSTRUCTION

Material for	2.170 m^2
CO_2 saving	1.292 kg

Compared to new roof trusses

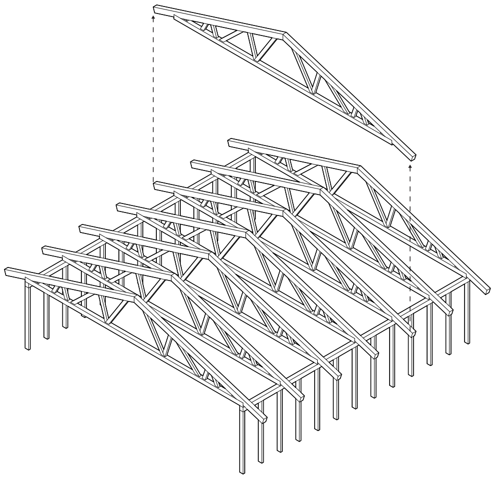
Treatment	**CLEAN**
Development	**CONCEPT**
Circulation-type	**REUSE**
Circulation-fraction	**100%**

The wood trusses have direct potential as a new roof construction. By making it visible in the interior, it can also contribute to aesthetics as well as convey the history of the former buildings they were harvested from.

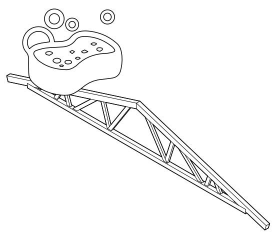
Casa M - Facet Studio

Wilsons Distilery - Gary Todd Architecture

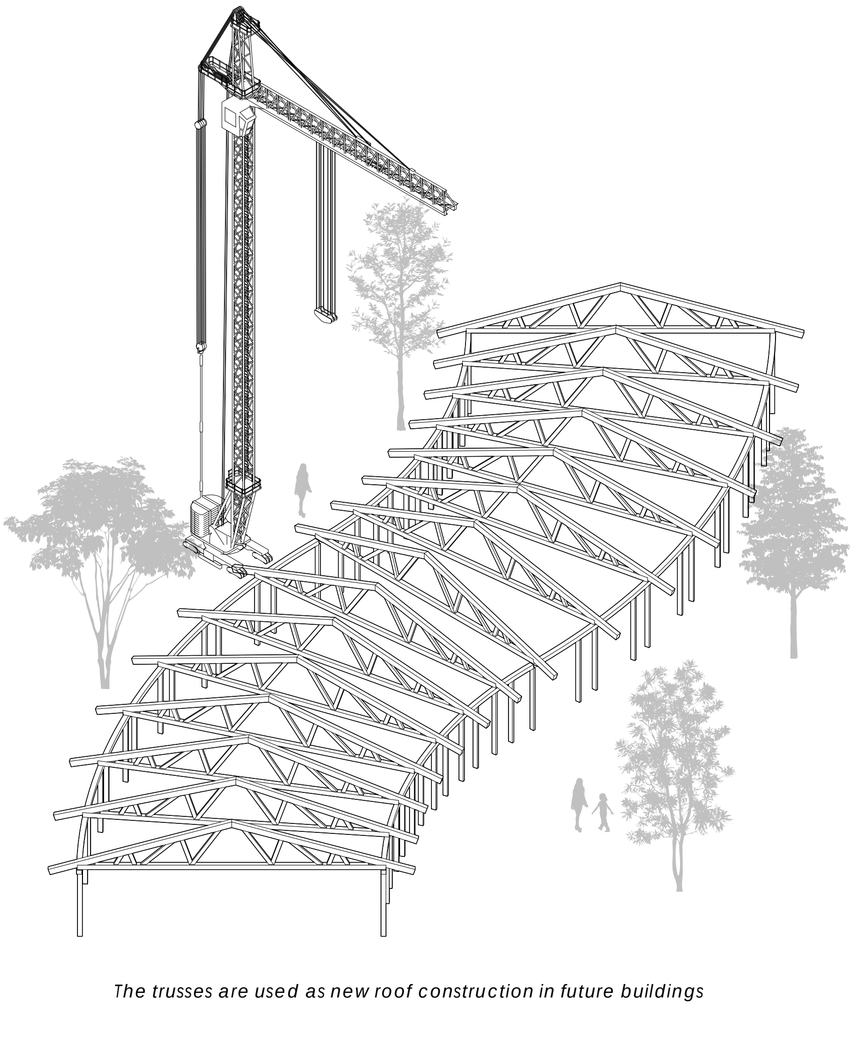
1.1 STRUCTURAL WOOD



The wood trusses are harvested from the existing buildings



The wood trusses are cleaned and treated



The trusses are used as new roof construction in future buildings

Visitor Centre - JDDK

Walk&Talk Pavilion - Divisare

PAVILION

Material for	**2.400 m²**
CO_2 saving	**2.970 kg**

Compared to a new wood construction

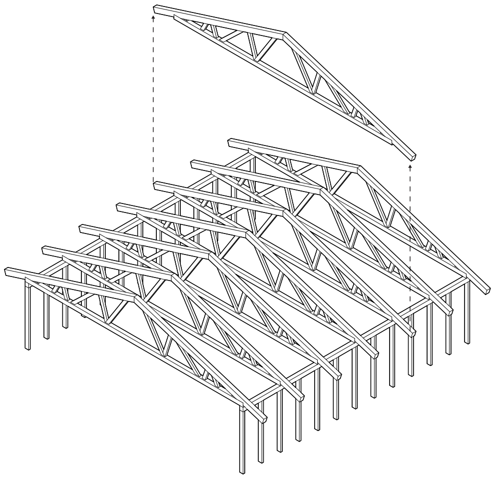
Treatment	**CLEAN**
Development	**CONCEPT**
Circulation-type	**REUSE**
Circulation-fraction	**80-100%**

The wood trusses and structural wood can be used in the landscape as covered pavilions or outdoor houses that can accommodate various functions and meeting places for users and the public. The dimensions of the existing wood will dictate the design of the outdoor houses.

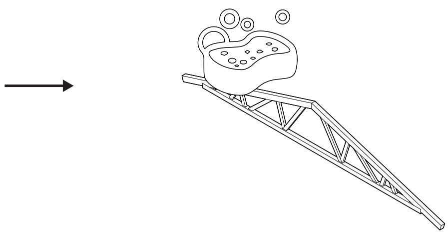
Terrace - Yoshichika Takagi

Wooden pavillion - Aor.fi

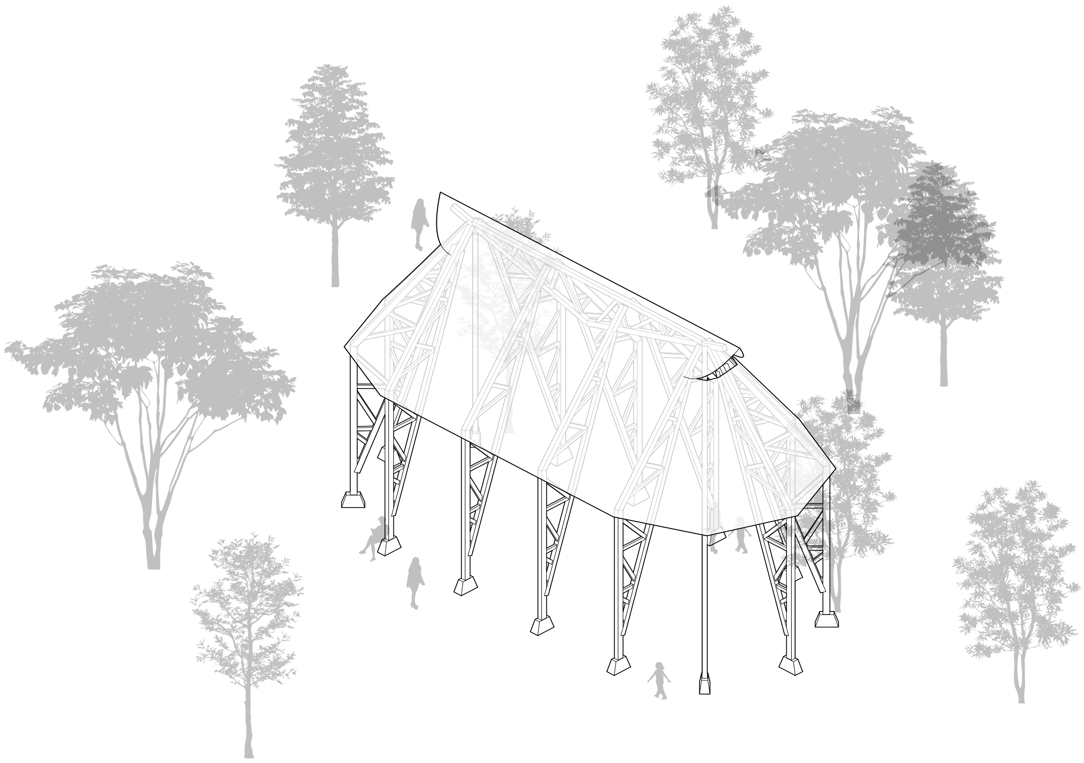
1.2 STRUCTURAL WOOD



The wood trusses are harvested from the existing buildings



The wood trusses are cleaned and treated



A pavilion is assembled from the wood and wood trusses

Wood sculpture - Thomas Dambo

LANDSCAPE ELEMENTS

Material for	**1-5 units**
CO_2 saving	up to **3.810 kg**

Compared to new wood installations

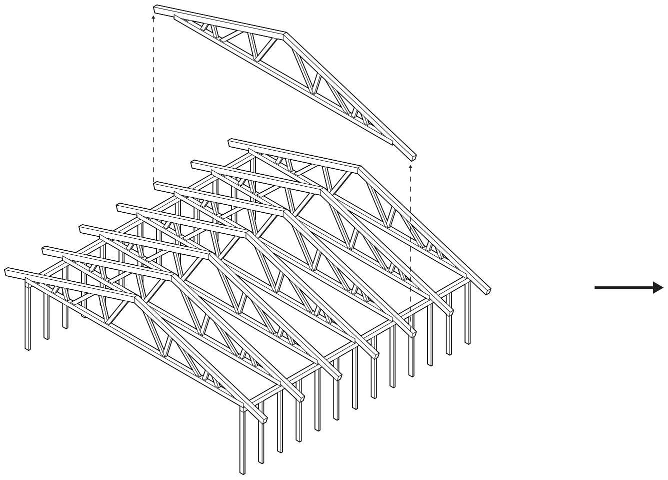
Treatment	**CLEAN**
Development	**CONCEPT**
Circulation-type	**REUSE**
Circulation-fraction	**50-100%**

The different wood fractions can be advantageously integrated into the design of the new outdoor areas. The wood can be used in installations that foster activities, promote discoveries -while also telling a story.

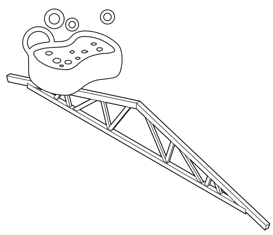
Wooden bridge - DP architects

'Wonder Wood' legeplads - VEGA Landskab

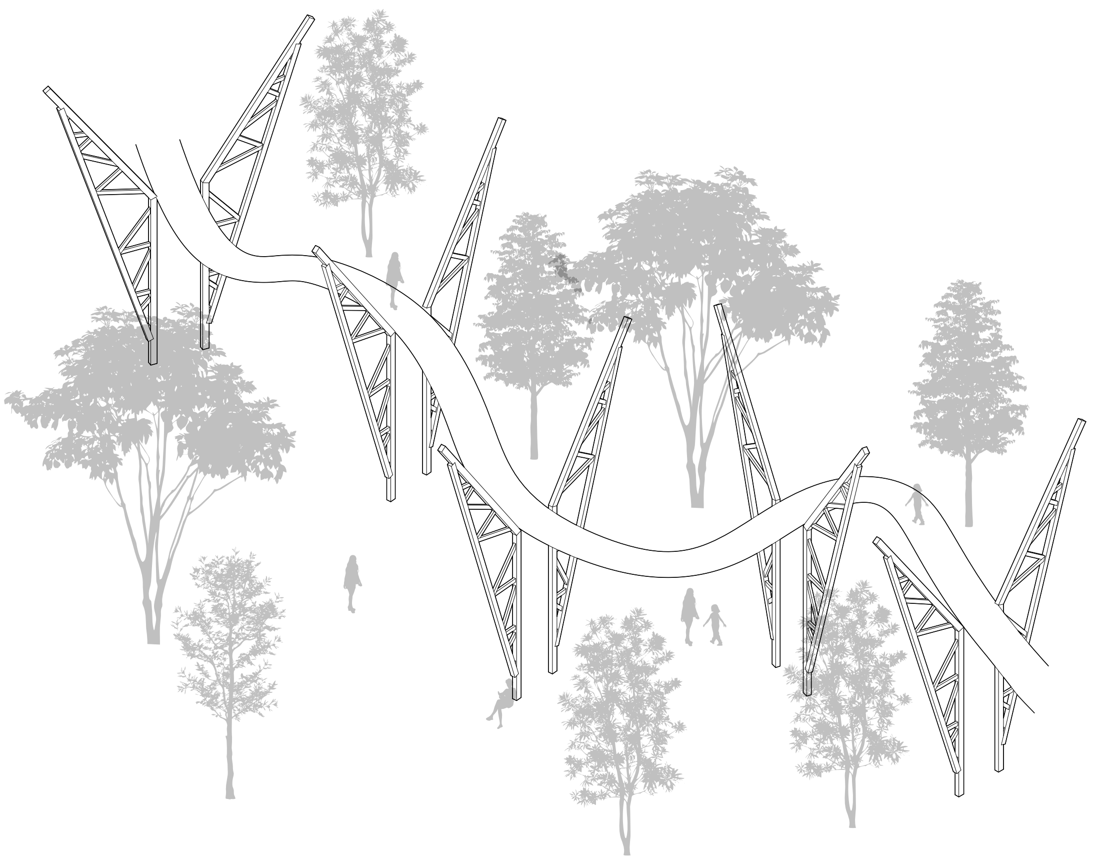
1.3 STRUCTURAL WOOD



The wood trusses are harvested from the existing buildings



The wood trusses are cleaned and treated



The landscape elements (e.g. land bridges) are completed with more wood or other materials

Glulam table - Porterbarnwood

Glulam box - Nola

FURNITURE

Material for	up to **150 units**
CO_2 saving	**3.050 kg**

Compared to new wood furniture

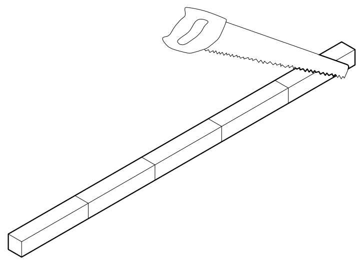
Treatment	**CUT**
Development	**CONCEPT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**85-90%**

Wooden furniture can be made by cutting up the wood and potentially combining it with metal fitting. The furniture can be used inside or in public spaces. The width of wood limits how much they can be transformed. However, the fittings can significantly increase the freedom in design.

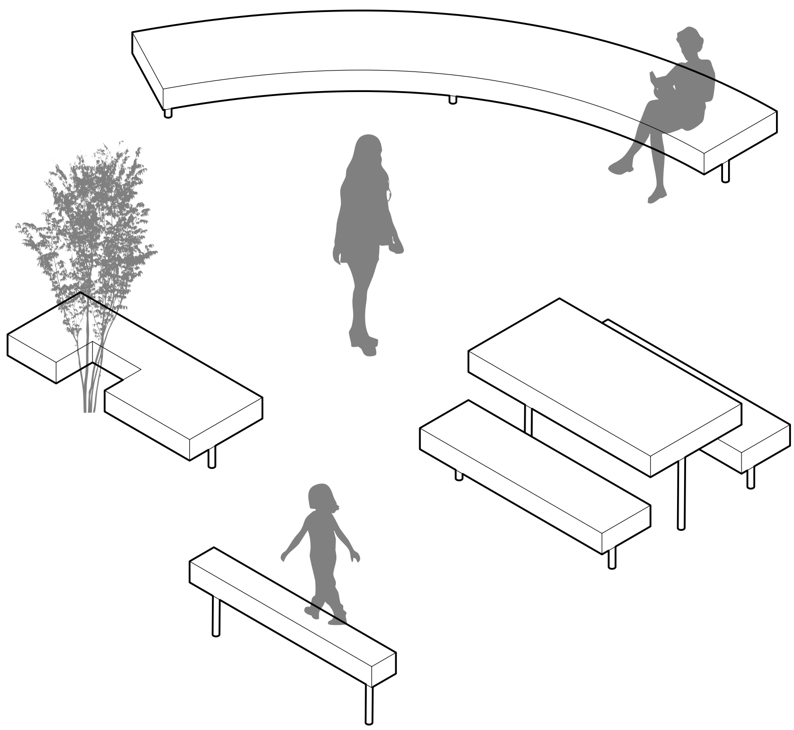
Bench - Ecoplaymobiliario

Terrace - Stephen Miller

1.4 STRUCTURAL WOOD

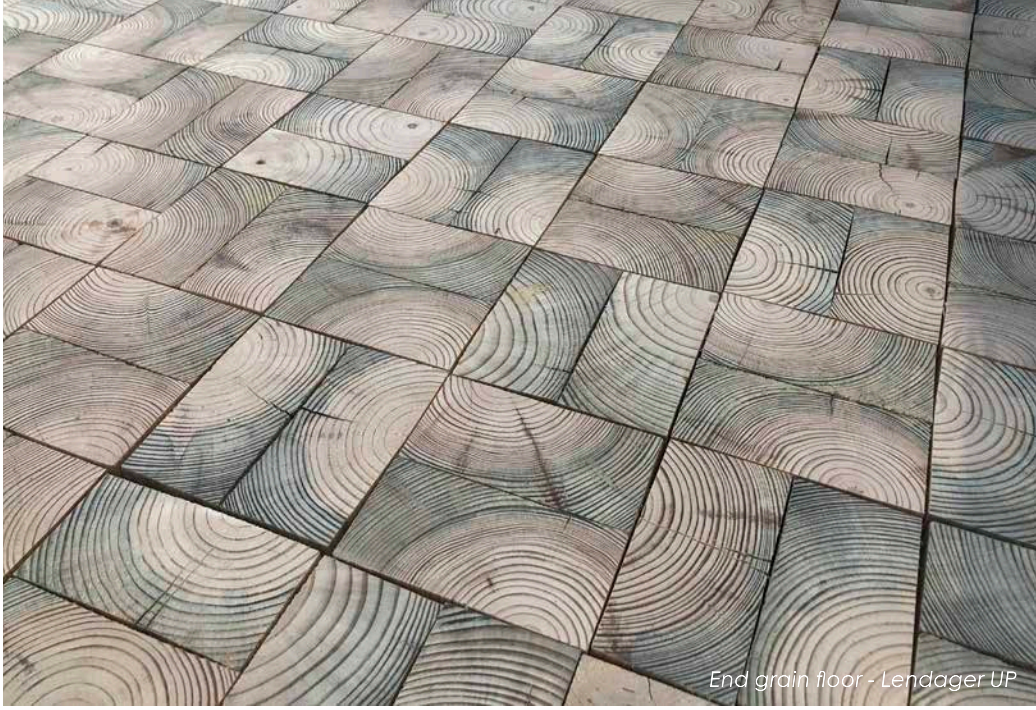


Wood elements are cut up



Cutouts are assembled into furniture

Wood floor - Kaswell Flooring



End grain floor - Lendager UP

END GRAIN FLOORING

Material for	**1.520 m²**
CO_2 saving	**10.150 kg**

Compared to new wooden floor

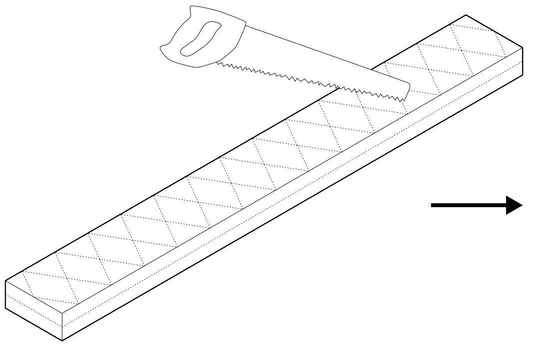
Treatment	**CUT**
Development	**PRODUCT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**100%**

As a solid floor solution, the structural wood can be cut across the fibre direction and glued tightly to the underlying layer. The specific dimensions of the structural wood can create unique patterns for the project in which it is used.

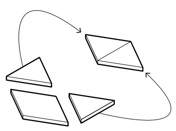
Floor - Old Wood LLC

Parquets originaux - Cigalespics

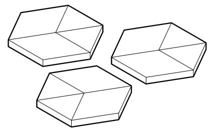
1.5 STRUCTURAL WOOD



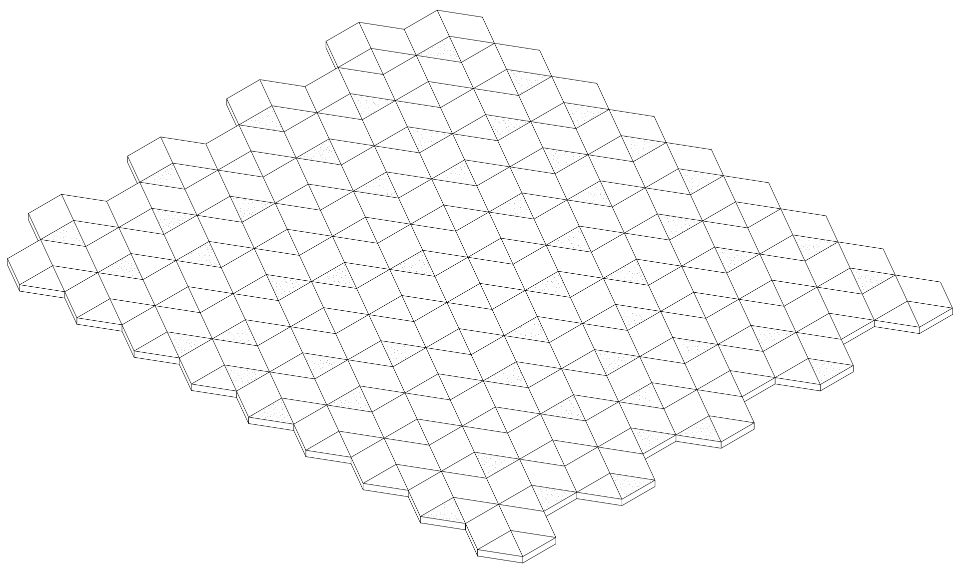
The wood is cut into small pieces



The pieces are assembled



The pieces are further assembled



The pieces are laid as a floor

Royal Arena - 3XN

Office Solvas - BAEYENS architecten

Cedar louvre - GG-loop

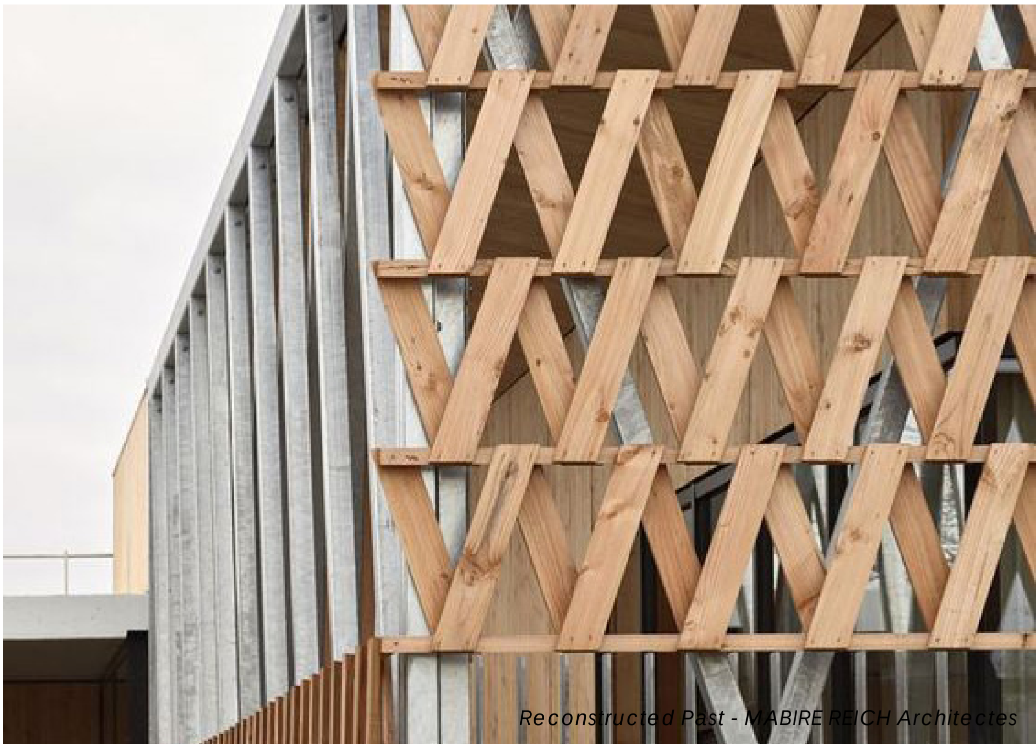
SUN SHADING

Material for	**1.190 m²**
CO_2 saving	**10.920 kg**

Compared to new wood cladding

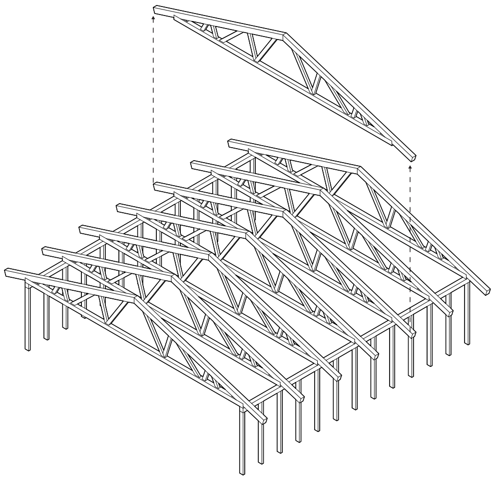
Treatment	**CUT**
Development	**CONCEPT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**90-100%**

To shield from the sun, wood can be cut up and used as a facade material. The wood can be cut up as pillars and used as an architectural element, or cut into smaller pieces as a more classic sun shading.

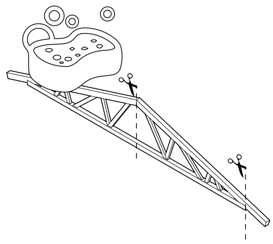


Reconstructed Past - MABIRE REICH Architectes

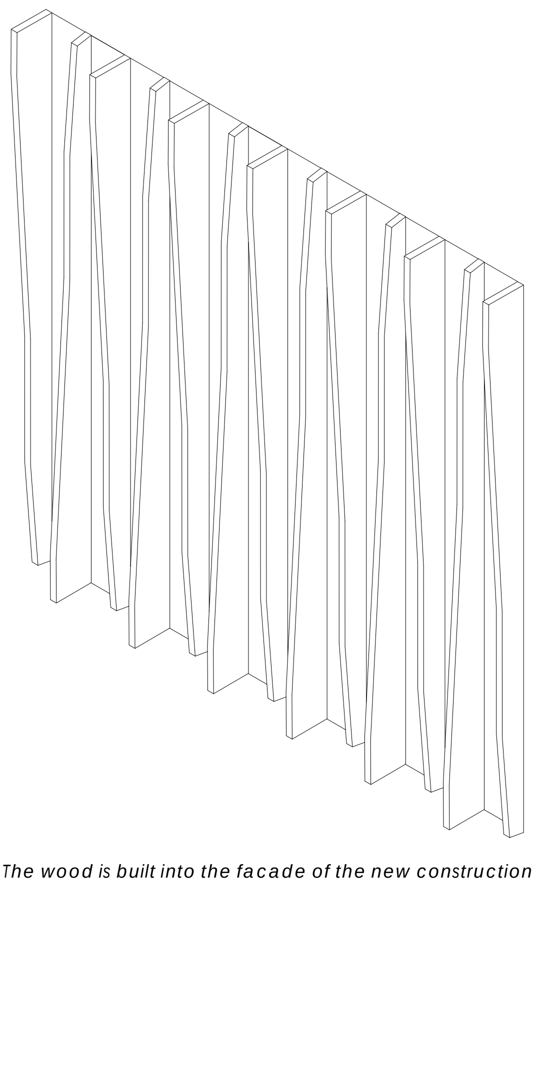
1.6 STRUCTURAL WOOD



The wood trusses are harvested from the existing buildings



The wood trusses are cleaned and cut



The wood is built into the facade of the new construction

Ceiling - Makelab

ACOUSTIC PANELS

Material for	**1.910 m²**
CO_2 saving	**18.490 kg**

Compared to 25 mm troldtekt

Treatment	**CUT**
Development	**PRODUCT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**100%**

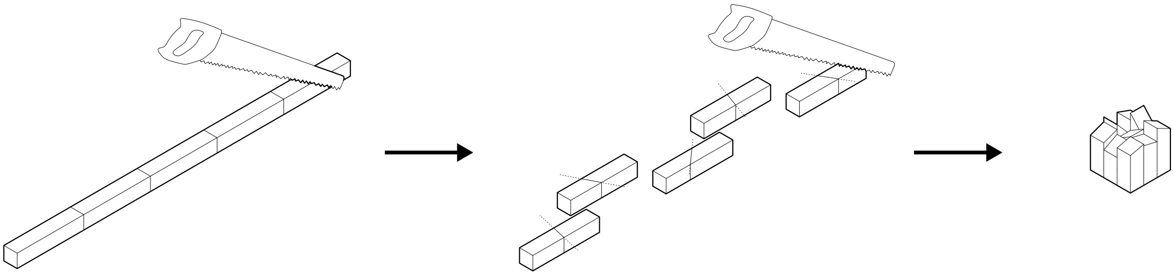
As an interior solution, the wood can be cut up and used as sound absorbing panels with upcycle felt behind. Because of the large amount of wood in the four existing buildings, it has a strong potential in new constructions.

Acoustic wall in EPIC - Lendager Group

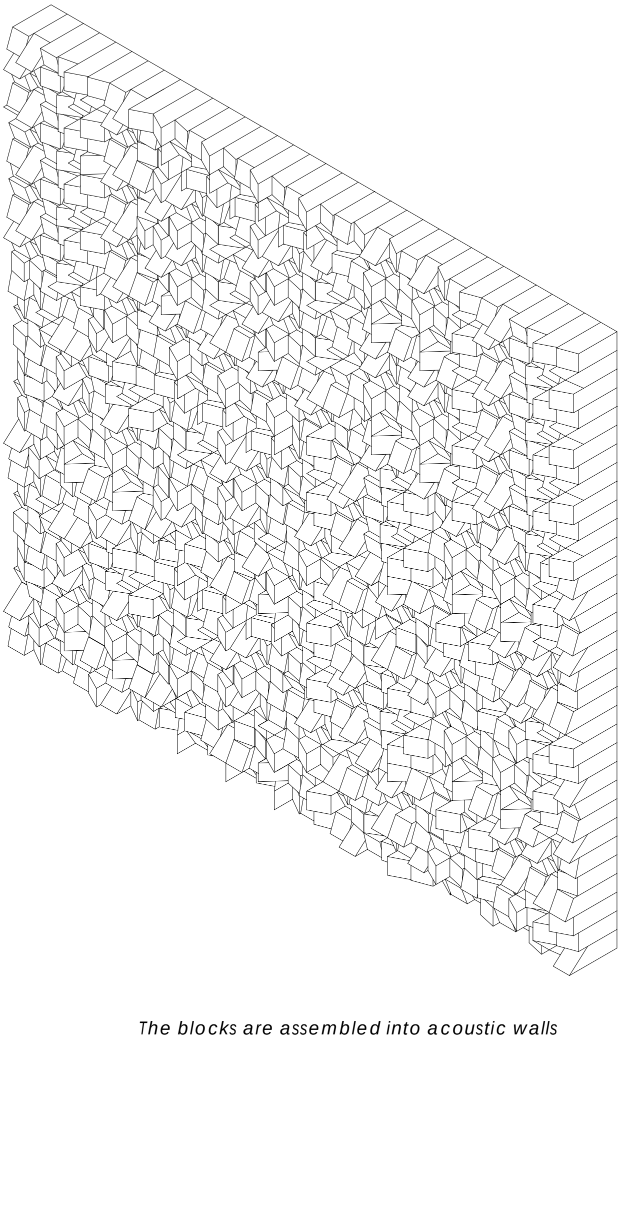
Wall - D3 Design Studio

Acoustic Panel - Lendager Group

1.7 STRUCTURAL WOOD



The wood elements are cut up *The wood undergoes final angulation by cutting* *The cuts are assembled into blocks*



The blocks are assembled into acoustic walls

Wood fiber insulation - Sunstrands

INSULATION

Material for	**1.060 m^3**
CO_2 saving	**2.480 kg**

Compared to new wood fiber insulation

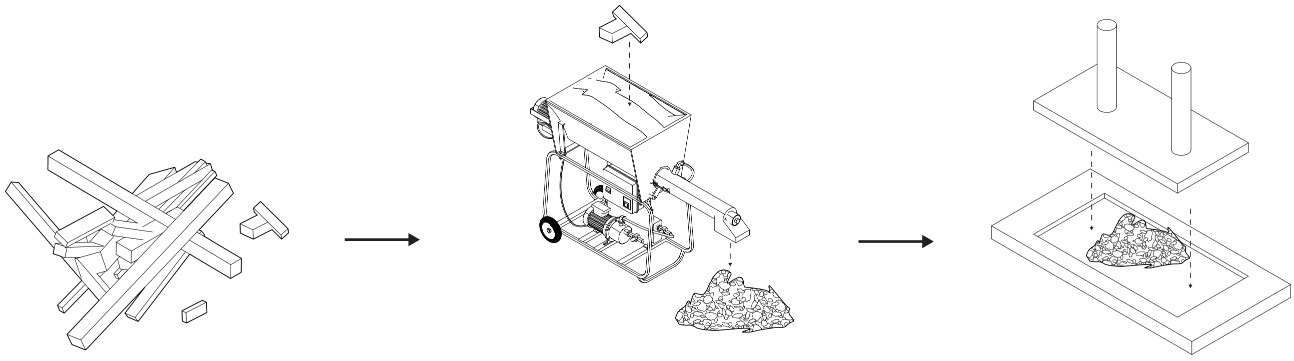
Treatment	**CRUSH**
Development	**CONCEPT**
Circulation-type	**DOWNCYCLE**
Circulation-fraction	**90%**

Wood that cannot be used in the new buildings can be included in the production of wood fibre insulation. This prevents burning and thus complete disposal of the material, but removes all structural and aesthetic qualities of the wood.

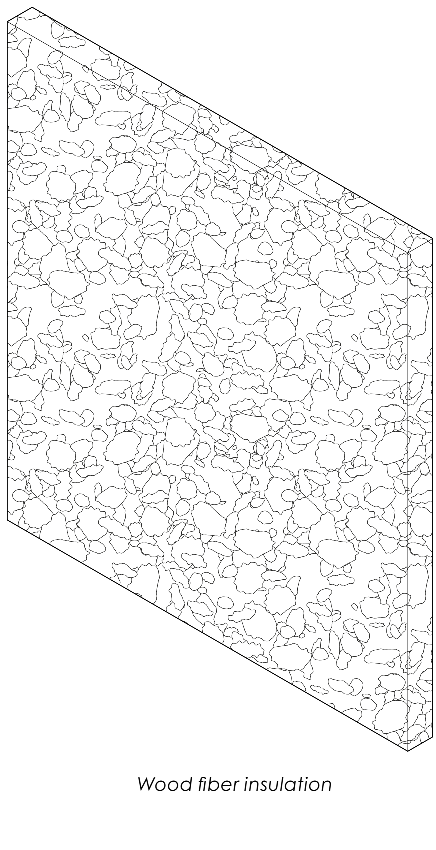
Wood fiber insulation - Manuela Lingnau

Wood fiber insulation - lab.org

1.8 STRUCTURAL WOOD



The residual wood is collected *The wood is crushed into small fibrs* *The fibres are mixed with binder in a mold*



Wood fiber insulation

DM2 Housing - OODA

Hostel Kitchen - Estudio ODS

OSB

Material for	**5.040 m^2**
CO_2 saving	**3.030 kg**

Compared to OSB from new wood

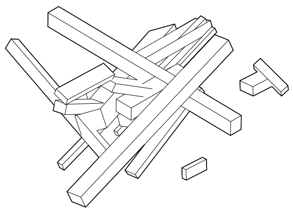
Treatment	**CRUSH**
Development	**PRODUCT**
Circulation-type	**DOWNCYCLE**
Circulation-fraction	**90%**

Wood without any use in the new construction, can be included in the production of OSB boards. Among other things, the boards can be used as a surface element in interior. The boards have a standard dimension of 1220x2440mm and can be post-treated.

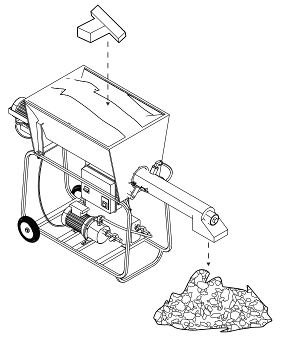
Ofiice - AUÁ arquitetos

Kitchen - Mode:lina

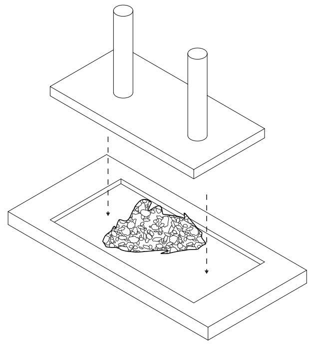
1.9 STRUCTURAL WOOD



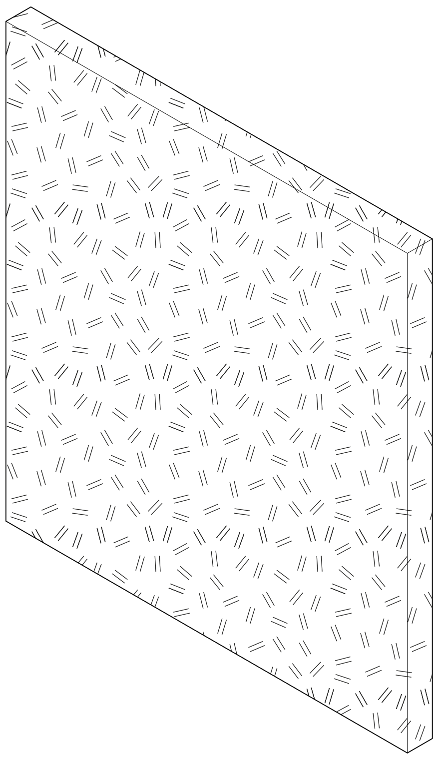
The residual wood is collected



The wood is crushed



The crushed wood is pressed into OSB



OSB

Learning Landscapes - Michelle Mathis

14-16mm Wood Chips - Realaquatics

WOOD CHIPS

Material for	**240 m³**
CO_2 saving	**1.670 kg**

Compared to ny træflis

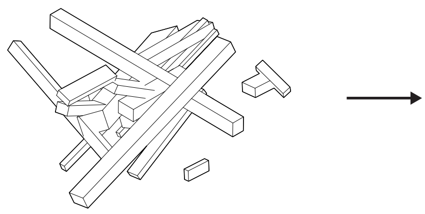
Treatment	**CRUSH**
Development	**PRODUCT**
Circulation-type	**DOWNCYCLE**
Circulation-fraction	**100%**

Wood without any use in the new construction, can be crushed into wood chips directly at the construction site. The wood ships can be used during the construction phase or as part of the landscape. However, any existing treatment on the wood must be considered.

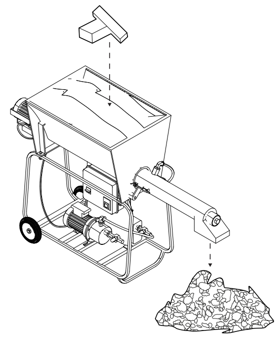
Natural playground - IndoorGarden

Forest garden - Jakob Hasle

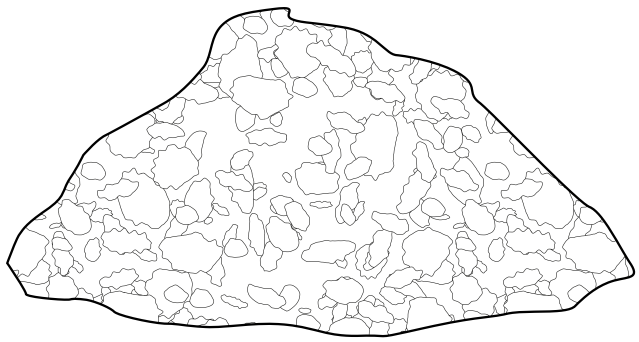
1.10 STRUCTURAL WOOD



The residual wood is collected



The wood is crushed



Wood chips

2. WOOD CLADDING

Wood cladding is a category that stands out as a material with potential across types, quantities, CO_2 saving potential and material output. Today we produce huge amounts of treated wood waste from renovation and demolition of buildings. In 2014, 2 million tons of wood waste were produced in Sweden.

As presented in the resource mapping of Hoppet, there are large amounts of window frames, doors, roofs, floor panels and facade cladding made of wood – all elements with a big circulation potential. Because wood is a renewable resource that sequesters CO_2 during its growth, the opportunities for circulation should be addressed and enhanced. There are exciting opportunities when upcycling, for example, wall cladding, acoustics and more.


Cladding


Window frames


Skirting boards


Particle board

	Backa Kyrkogata 3	Backa Kyrkogata 7	Backa Kyrkogata 9	Biskops-gatan 8	Total
Cladding	328 m²	266 m²	236 m²	306 m²	1.136 m²
Window frames	13,2 m²	18,5 m²	20,0 m²	53,0 m²	105 m²
Skirting boards	4,8 m²	2,8 m²	1,3 m²	15,2 m²	24,1 m²
Particle board	186 m²		50,0 m²	106 m²	342 m²
TOTAL	**532 m²**	**287 m²**	**307 m²**	**480 m²**	**1.607 m²**
	9,3 m³	**6,4 m³**	**6,3 m³**	**10,1 m³**	**32,0 m³**

CLEN

- *Reuse* → 2.1 **FACADE**
  The cladding wood is reused as a facade
- *Upcycle* → 2.2 **INTERIOR**
  The wood is used for interior installations

CUT

- *Upcycle* → 2.3 **SHINGLES**
  The wood is cut to facade shingles
- *Upcycle* → 2.4 **ACOUSTIC PANELS**
  The wood is assembled to panels

CRUSH

- *Downcycle* → 2.5 **INSULATION**
  The wood is crushed to fibres
- *Downcycle* → 2.6 **OSB**
  The wood is crushed and pressed together
- *Downcycle* → 2.7 **WOOD CHIPS**
  The wood is crushed to chips

Shown in Structural Wood Chapter

Charred facade - Lendager Group

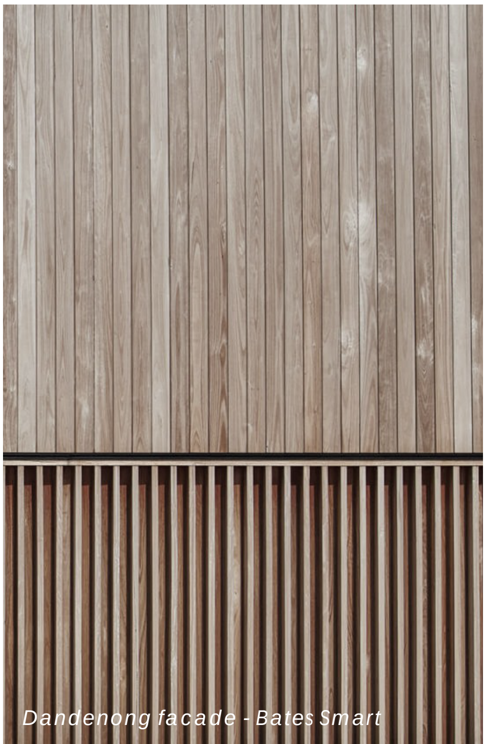
Sjöhusen facade - Dinell Johansson

FACADE

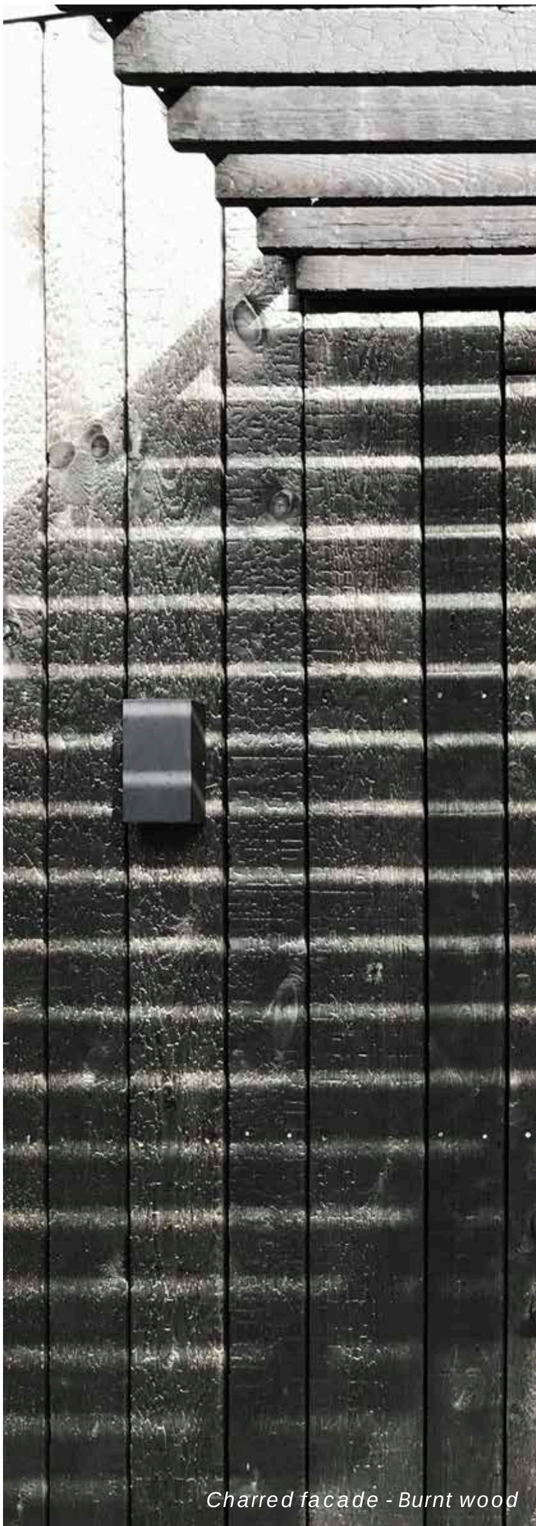
Material for	**910 m²**
CO_2 saving *Compared to new wood facade*	**8.320 kg**

Treatment	**CLEAN**
Development	**PRODUCT**
Circulation-type	**REUSE**
Circulation-fraction	**90-100%**

Wood cladding has the potential to become a new facade by sorting it and in some cases cleaning it thoroughly for paint and nails. The different cladding fractions can be treated differently to provide varying facade textures and patterns.

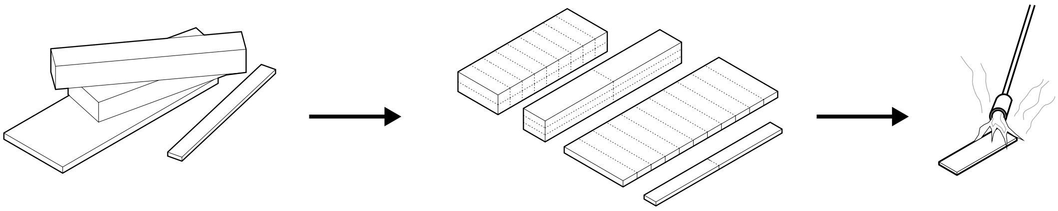


Dandenong facade - Bates Smart

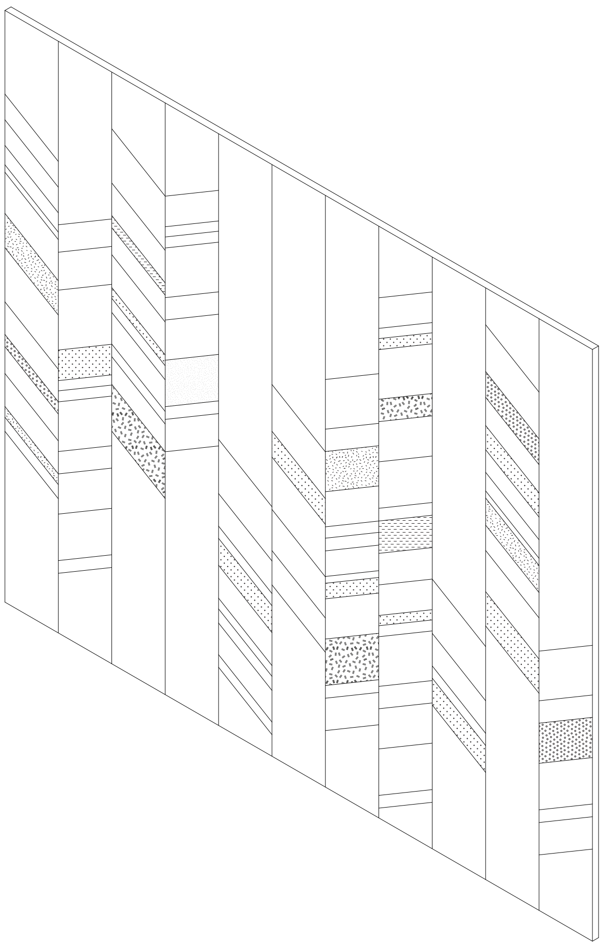


Charred facade - Burnt wood

2.1 WOOD CLADDING



The wood is collected *The wood is sorted* *The wood is processed*



The processed wood is set up as a new facade

Wood panel - Lendager Group

Wood wall - Craftwand Living

INTERIOR

Material for	**470 m^2**
CO_2 saving	**2.120 kg**

Compared to new wood facade

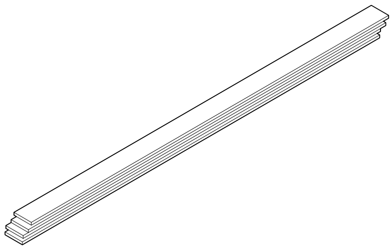
Treatment	**CLEAN**
Development	**PRODUCT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**80-100%**

Interior wood can be upcycled for partition walls and other installations for indoor use. The installations can have both practical and aesthetic features. By using different fractions of wood diversified expressions of the installations can be achieved.

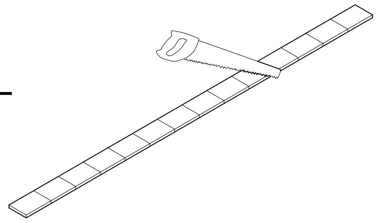
Store interior - Isabel Marant

KPMG Reception - Jack Flanagan

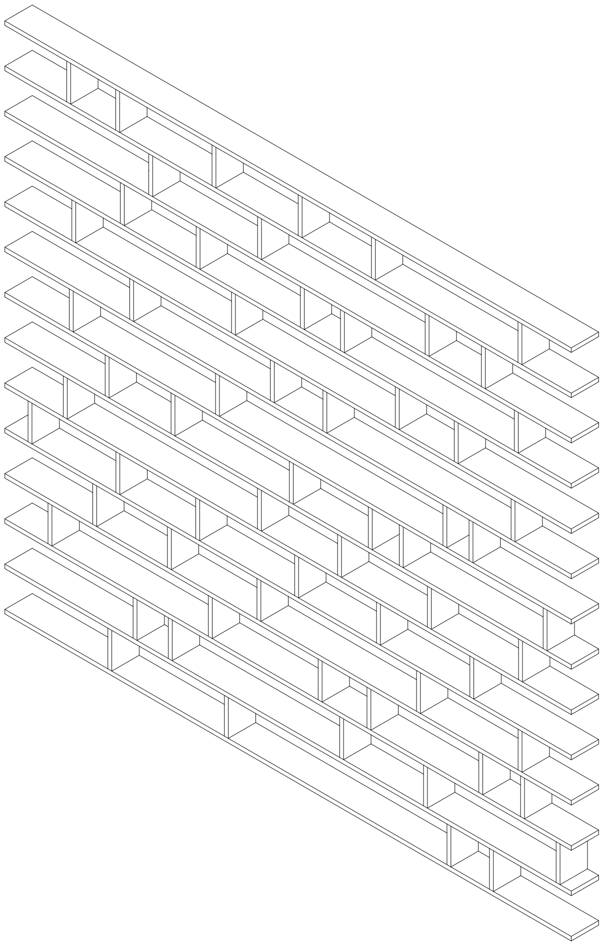
2.2 WOOD CLADDING



The wood is collected

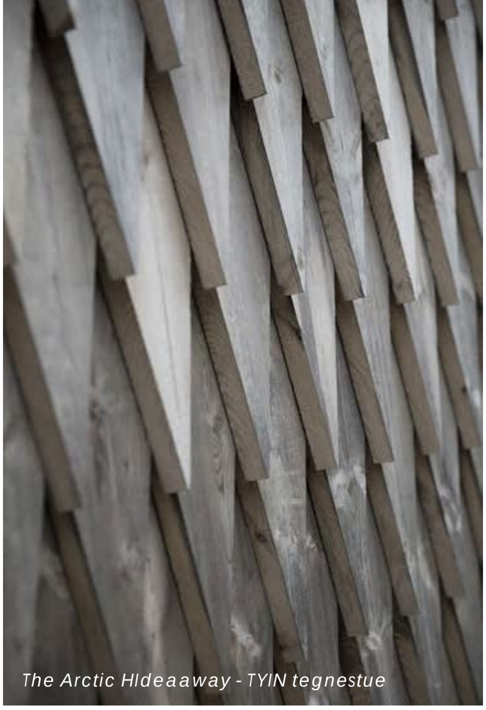


Boards are adapted to their new function



The new interior installations are built

Tower House - Austin Maynard Architects



The Arctic HIdeaaway - TYIN tegnestue

SHINGLES

Material for	**460 m²**
CO_2 saving	**4.210 kg**

Compared to new wood facade

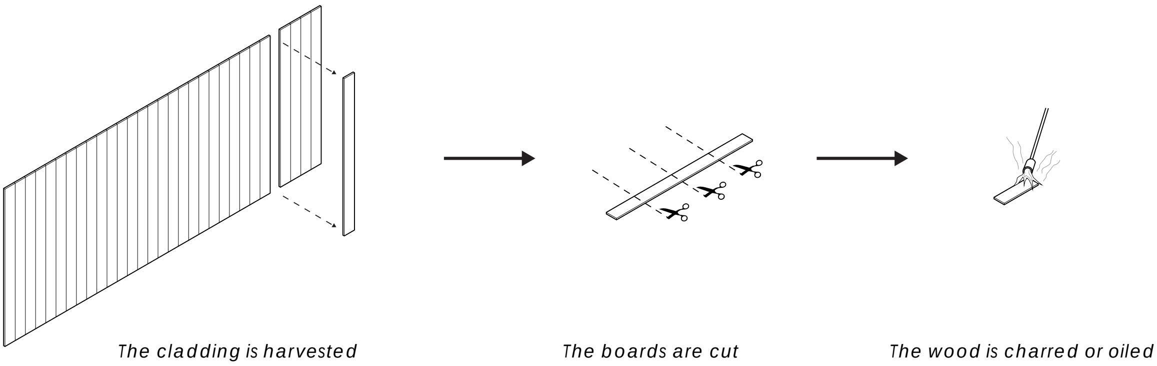
Treatment	**CUT**
Development	**PRODUCT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**100%**

Wood cladding can be cut up to shingles and used as new cladding for future buildings. The shingles can have varying shapes when used as facade element and should be treated with either heat or oil rather than chemicals or paint.

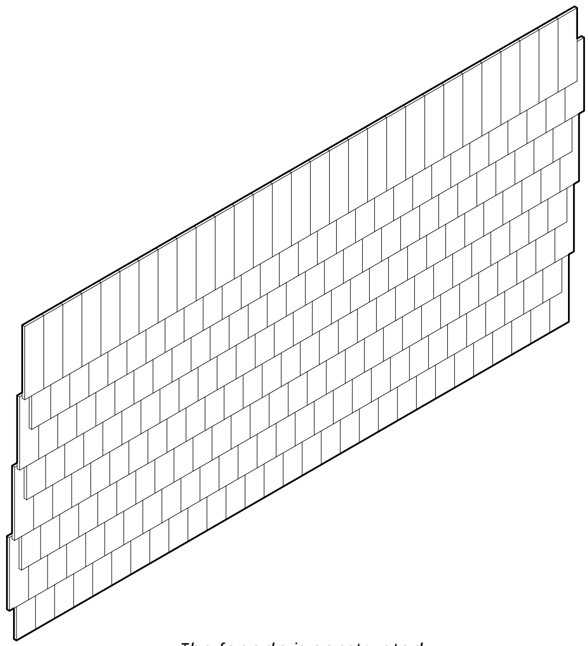
Wood Shingles - Sohei Nakanishi Design

Upwood Shingles - Lendager Group

2.3 WOOD CLADDING



The cladding is harvested — *The boards are cut* — *The wood is charred or oiled*



The facade is constructed

3. CONCRETE ROOF TILES

Roof tiles are a typical Scandinavian building element that previously dominated every cityscape. It is an often overlooked building element. However, in many cases, including these four buildings, they are large in quantity, CO_2 saving potential and output quantity.

Concrete roof tiles are, in contrast to traditional clay roof tiles, cast in concrete. Yet, because of their similar shape and function, the circulation options are very similar. It is mainly the distinctive shape of the tiles that offer exciting design possibilities.

The mapped concrete roof tiles have some interesting circulation possibilities due to the large amount present. Previously, they had not been a major focus of circulation. However, we believe that the amount of circulated concrete pantiles will increase in future demolition and renovations cases, allowing new buildings with alternative expressions.

Concrete Roof Tiles

	Backa Kyrkogata 3	Backa Kyrkogata 7	Backa Kyrkogata 9	Biskops-gatan 8	Total
TOTAL		**683 m²**	**520 m²**	**771 m²**	**1.974 m²**
		8,9 m³	**6,8 m³**	**10,0 m³**	**25,6 m³**

CLEAN

- *Reuse* → **3.1 ROOFING**
  The tiles are reused directly as a new roof
- *Reuse* → **3.2 PARTITION WALL**
  The tiles are stacked as an interior wall
- *Reuse* → **3.3 SUN SHADING**
  The tiles are set up as solar shading system
- *Reuse* → **3.4 LIGHT FACADE**
  The tiles are put up vertically as a facade

CUT

- *Upcycle* → **3.5 HEAVY FACADE**
  Half tiles are put up vertically with mortar

CRUSH

- *Upcycle* → **3.6 GABIONS**
  The tiles are crushed and put in gabions
- *Downcycle* → **3.7 GRAVEL**
  Crushed tiles are used as gravel

Aarhus University - C.F. Møller

Roof tiles

ROOF

Material for	**1.970 m^2**
CO_2 saving	**8.330 kg**

Compared to new concrete roof tiles

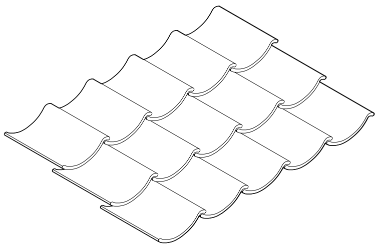
Treatment	**CLEAN**
Development	**PRODUCT**
Circulation-type	**REUSE**
Circulation-fraction	**100%**

In a direct reuse scenario, the tiles can be used as roofing again. The roof tiles may be used together with new ceramic roof tiles to create new aesthetics. They can be used as roofing for both buildings and outdoor houses or sheds.

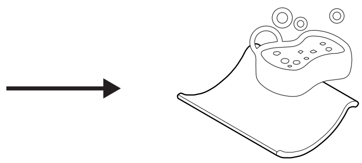
Old Hollow roof tiles – Advance Roofing

Klass Kuiken

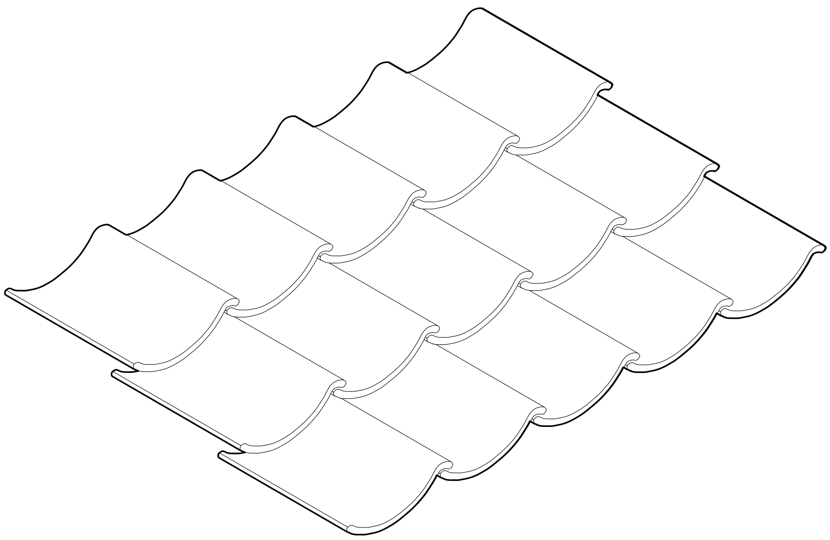
3.1 CONCRETE ROOF TILES



The roof tiles are harvested



The roof tiles are cleaned



The roof is reassembled

Warehouse 8B - grupo AARQUITECTURA

Divider - Designwire

PARTITION WALL

Material for	**660 m²**
CO_2 saving	**1.350 kg**

Compared to new gypsum wall

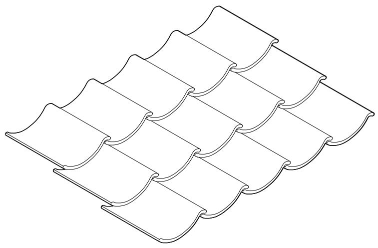
Treatment	**CLEAN**
Development	**PRODUCT**
Circulation-type	**REUSE**
Circulation-fraction	**100%**

As an aesthetically raw addition to the interior of the new buildings, roof tiles can be stacked into perforated space divider that intentionally shows the old material in a new feature. The stacking can be done in different patterns depending on the desired perforation.

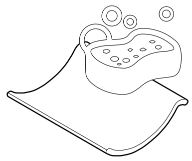
Drywall - Sid Snyder

Serpentine Pavilion 2018 - Frida Escobedo

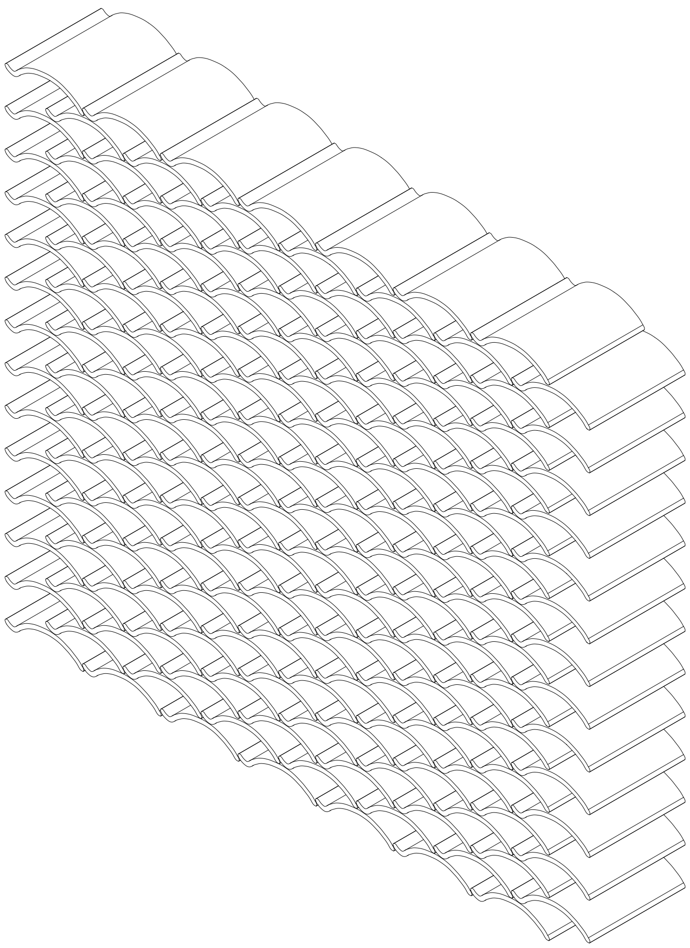
3.2 CONCRETE ROOF TILES



The roof tiles are harvested



The roof tiles are cleaned



The roof tiles are stacked to a perforated wall

The Beehive - Luigi Rosselli

Xinjin zhi museum - Kengo Kuma

SUN SHADING

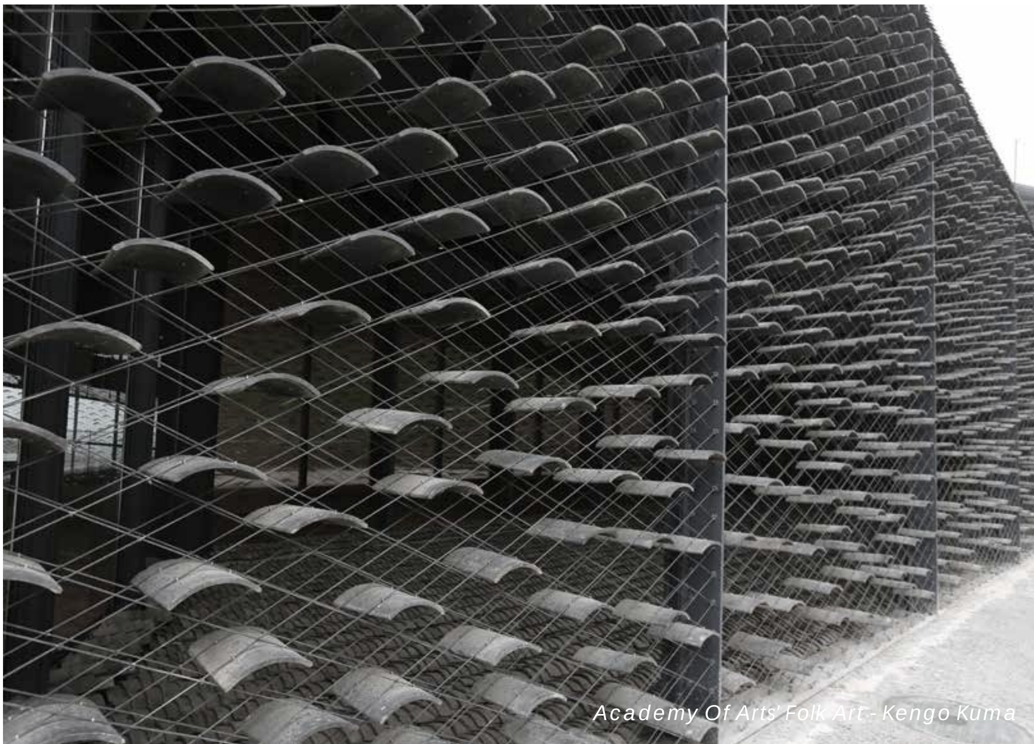
Material for	**5.920 m²**
CO_2 saving	**13.530 kg**

Compared to new wood sun shading

Treatment	**CLEAN**
Development	**CONCEPT**
Circulation-type	**REUSE**
Circulation-fraction	**100%**

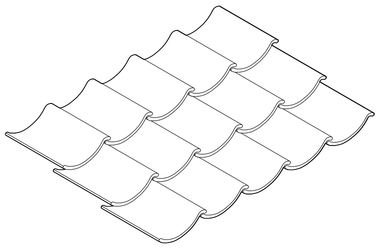
Roof tiles can be included in new construction as an add-on layer on the outside of a glass facade oriented towards the south. The design of this layer can be static or kinetic and make use of the unique shape of the tile to create distinctive facades.

Urban House - Jaya Malaysia

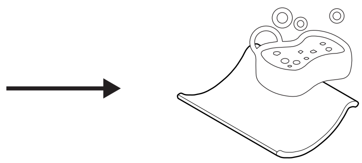


Academy Of Arts' Folk Art - Kengo Kuma

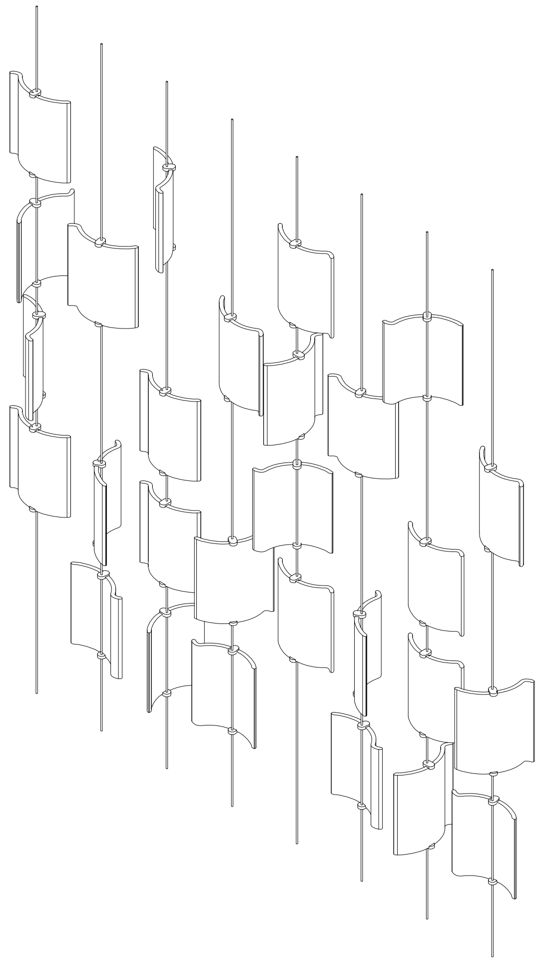
3.3 CONCRETE ROOF TILES



The roof tiles are harvested



The roof tiles are cleaned



Roof tiles are added to a grid in intervals to filter sunlight

Residência Pátio - META

Facade - VOLT architecten

LIGHT FACADE

Material for	**1.970 m^2**
CO_2 saving	**18.050 kg**

Compared to new wood facade

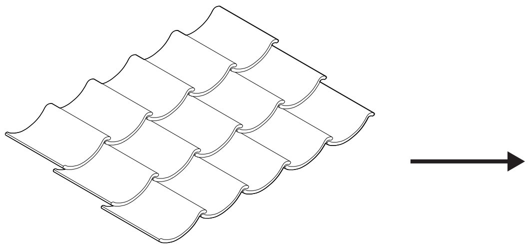
Treatment	**CLEAN**
Development	**PRODUCT**
Circulation-type	**REUSE**
Circulation-fraction	**100%**

Roof tiles can be stacked vertically as a new, light facade. Starting the roof tile facade from the bottom of the building, puts the material at eye level with the users. The roof tiles can also be used on a curved facade.

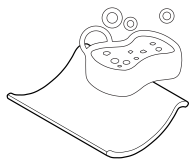
Facade Mockup - Lendager Group

Recycled Terracotta Roof Tiles - Doorroof

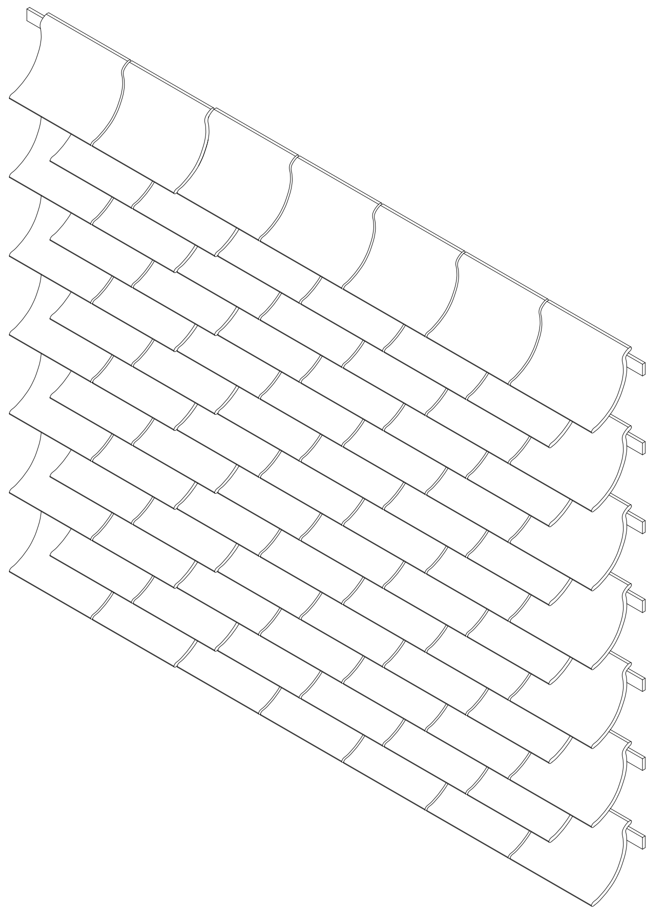
3.4 CONCRETE ROOF TILES



The roof tiles are harvested



The roof tiles are cleaned



Tiles are put up vertically as a facade

Facade mockup - Lendager Group

HEAVY FACADE

Material for	**990 m²**
CO_2 saving	**160 kg**

Compared to new wood facade

Treatment	**CLEAN**
Development	**PRODUCT**
Circulation-type	**REUSE**
Circulation-fraction	**50%**

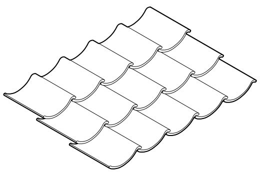
As a unique facade, roof tiles can be divided into several pieces before being walled up with mortar as a new facade. In this way, all the shapes of the tiles are seen with great depth. For greater variety, other tiles or bricks can be harvested from nearby buildings.

Lobby Lounge - Nobu

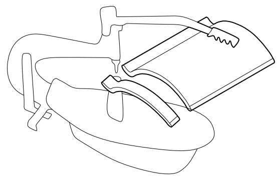
Stacked tiles

Yinzhou - Wang Shu

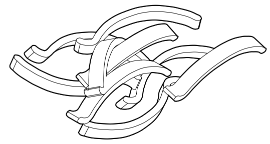
3.5 CONCRETE ROOF TILES



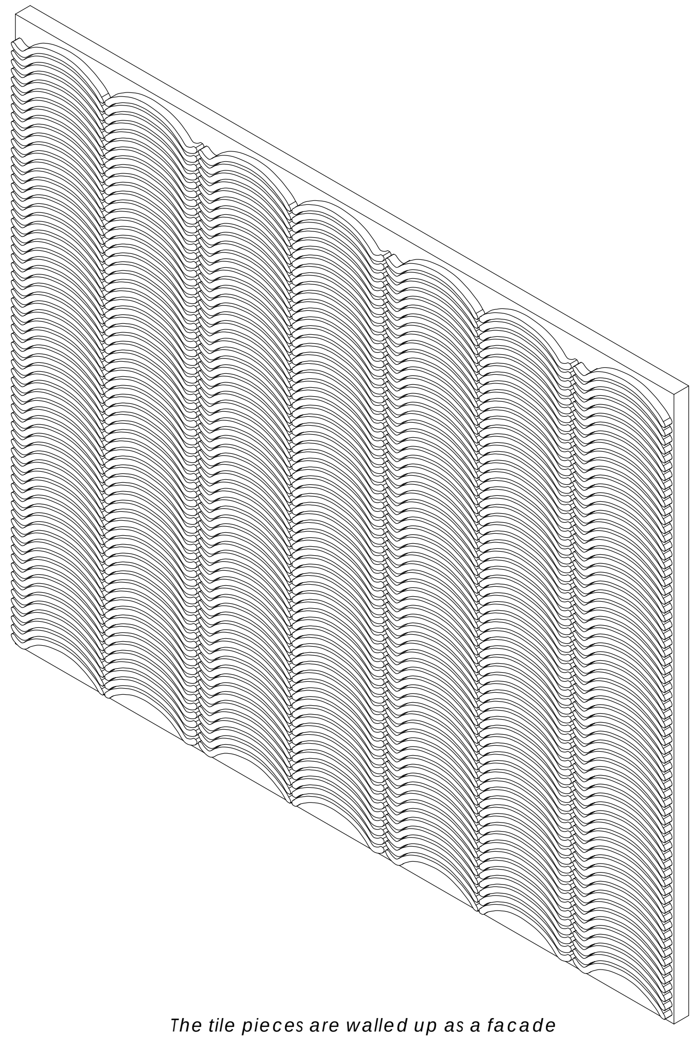
Roof tiles are harvested



The tiles are cut



The tile pieces are assembled



The tile pieces are walled up as a facade

Joost Bakker -Viktoria

Jardin Y Piedras Piedras Jardin U 8

GABIONS

Material for	**60 m²**
CO_2 saving	**780 kg**

Compared to gabions with rocks

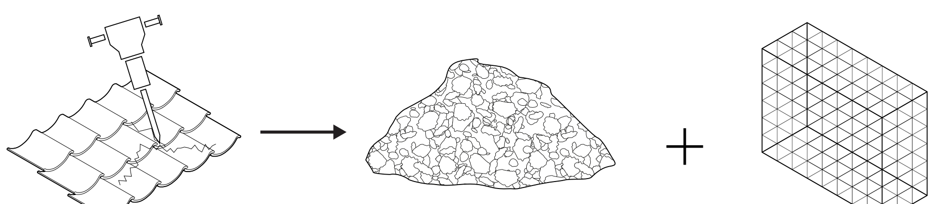
Treatment	**CRUSH**
Development	**PRODUCT**
Circulation-type	**UPCYCLE**
Circulation-fraction	**95%**

Gabion nets can be filled with crushed tiles to be used as facades, thermal mass inside buildings and as half walls. Gabion nets frame the raw expression of the tiles whose red and grey colour will still be visible.

Stanton Williams Architect

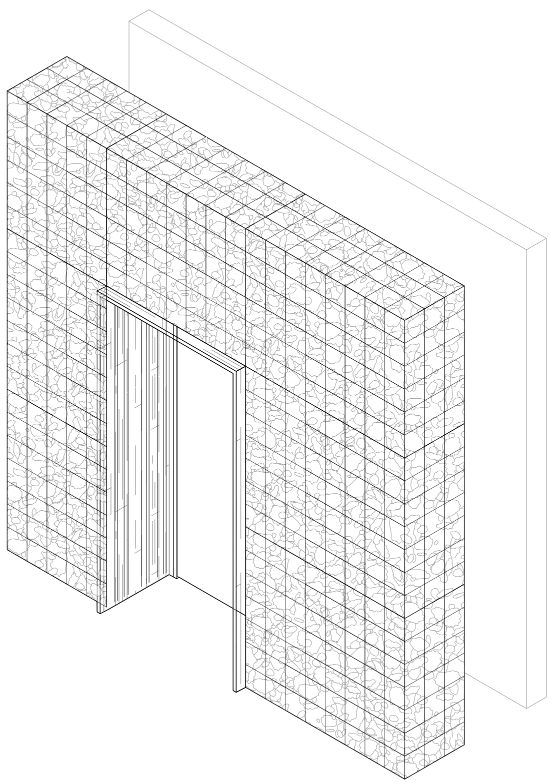
REX House - FGMF Arquitetos

3.6 CONCRETE ROOF TILES



The roof is demolished

The rubble is collected and filled into gabions



Gabions are combined to wall elements

Vertus Landscape Architects

Gravel planters on the High Line - James Corner Field Operations

GRAVEL

Material for	**30 m^3**
CO_2 saving	**230 kg**
Compared to new gravel	

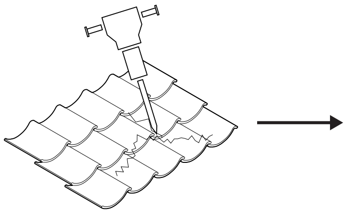
Treatment	**CRUSH**
Development	**PRODUCT**
Circulation-type	**DOWNCYCLE**
Circulation-fraction	**100%**

The roof tiles that are not used in the new buildings may be crushed to gravel and used directly in the area. The tiles lose their structural properties, but their red and grey hue can be used as an aesthetic element in the design of the landscape.

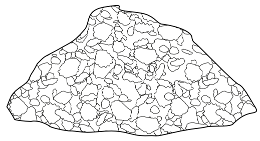
Can Picafort - TEd'A arquitectes

Anna Forslund / Sweden

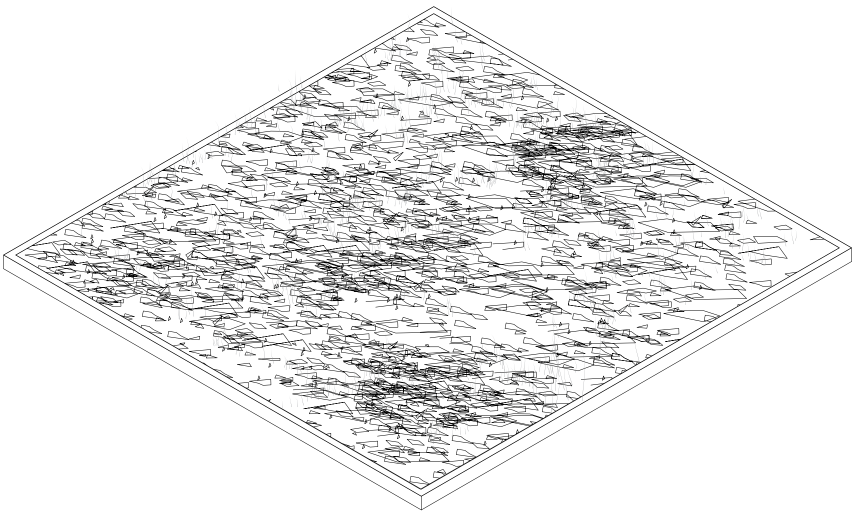
3.7 CONCRETE ROOF TILES



The roof is demolished



The gravel is collected



The roof tile gravel is used as substrates or paving

GLOSSARY

EXTERIOR

Concepts

Sun Shading
1.6
Structural wood

Sun Shading
3.3
Concrete roof tiles

Products

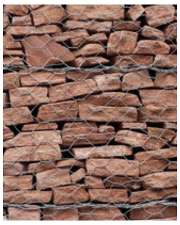
Facade
2.1
Wood cladding

Shingles
2.3
Wood cladding

Roofing
3.1
Concrete roof tiles

Light Facade
3.4
Concrete roof tiles

Heavy Facade
3.5
Concrete roof tiles



Gabions
3.6
Concrete roof tiles

INTERIOR

Products

End Grain Floor
1.5
Structural wood

Acoustic Panels
1.7
Structural wood

Interior
2.2
Wood cladding

Partition Wall
3.2
Concrete roof tiles

LANDSCAPE

Concepts

Landscape Elements
1.3
Structural wood

Furniture
1.4
Structural wood

Products

Wood Chips
1.10
Structural wood

Gravel
3.7
Concrete roof tiles

CONSTRUCTION

Concepts

Roof construction
1.1
Structural wood

Pavillion
1.2
Structural wood

Insulation
1.8
Structural wood

Products

OSB
1.9
Structural wood

IDEAS BRING VALUE

MANY OPPORTUNITIES

As you have seen there are countless of opportunities for circulation of materials. Only the mind sets the limit.

We have presented ideas for circulation of structural wood, wood cladding and concrete roof tiles, which is only a small part of the total materials mapped.

Despite this, not only ideas but actual concepts and products are presented across the three categories, treatment methods (clean,. cut, crush) and output materials (exterior, interior, landscape and construction).

The question that is left is not what, but rather how the materials used in existing buildings can be processed into new building materials - competing on quality, price and aesthetics.

CHAPTER 5
NEXT STEP

POTENTIALS FOR CIRCULATION

STRUCTURAL WOOD

The four buildings contain an interesting amount of structural wood. This brings a big potential for circulating the existing building materials in the new construction of Hoppet. Alternatively it can be circulated as new exterior or interior wood cladding.

Structural wood is specifically good to circulate due to the typical low treatment of materials, relatively big sizes and low amount of pollution of paint and nails.

Total amount: 95 m³
CO_2-savings from direct use:
3.812 Kg

CONCRETE

We have mapped a relatively large amount of concrete in the total building mass. Therefore, from a material and environmental perspective, we should find a solution for circulation. Normally, when circulating concrete two methods can be used; 1) Crushing and using as aggregate for new concrete or 2) direct reuse of structural elements such as floor decks. However, in this resource mapping a large amount of concrete is foundational meaning that we can expect the concrete to be contaminated by soil. This limits the amount of circular concrete to be used in the Hoppet project, where circulation of the total amount is not deemed achievable.

Total amount: 460 m³
CO_2-savings from direct use:
28.277 KG

STEEL

In the resource mapping, we mapped different types of steel including water piping and grates. These should be considered to be either reused directly or sent to producers for reuse. Steel is mostly recycled, but often this is done through heavy processing where the material is melted and shaped into something new. This processing emits a lot of CO_2. That is why we recommend investigating potentials for more direct reuse though it can be difficult due to the fairly small volume.

Total amount: 1.5 ton
CO_2-savings from direct use:
2.969 KG

CONCRETE ROOF TILE

There are large amounts of concrete roof tiles across the four buildings with an interesting potential for circulation. Circulating the roof tiles in the new construction gives both financial and maintenance benefits. Financially, because they just need to be sorted out and cleaned, maintenance-wise, because undamaged tiles have just been through a better quality-check than new tiles. Using old roof tiles in a new construction gives the new building a distinctive and aesthetic touch, while it preserves the identity of the old buildings and contributes to reducing waste issues.

Total amount: 1.974 m^2
CO_2-savings from direct use:
8.348 KG

GLASS

The four buildings have a lot of windows in different sizes and shapes that are in good conditions. This leaves us with a big potential for circulation. Usually, windows represent a high expense in new construction projects due to the material's purchase cost and complexity. Also, a large amount of CO_2 emission can be saved by circulating glass due to the materials high CO_2 footprint per m_2. Therefore, further work on solutions for circulation should be carried out. Circulation potentials include new outdoor windows (triple layer glazing), partition wall and green houses (double layer glazing). If reusing or upcycling existing glasses, the amount should be supplemented by glasses from other locations.

Total amount: 251 m^2
CO_2-savings from direct use:
14.939 KG

WOOD CLADDING

Today, wood is often circulated, but mainly through downcycling, where it is crushed into OSB plates. Across the four buildings, we see an exciting potential for direct reuse of part of the wood materials and upcycling of other parts where new wood treatment methods can help strengthen both quality and aesthetics. Circulation of wood cladding should include both interior and exterior wood, and when upcycled, it can become nice facade and wall cladding.

Total amount: 1.583 m^2
CO_2-savings from direct use:
12.224 KG

FROM LINEAR TO CIRCULAR VALUE CHAIN

FROM DEMOLISHION TO NEW CONSTRUCTION

A prerequisite to build a fossil free preschool in Göteborg Stad, is sustainable business - technical, practical and economical. The following chapter will highlight the process from completed mapping to successful implementation of circulated materials in a new building.

The need for changes in the value chain is of central importance to create a profitable business model when circulating building materials. But, in order to understand what direction we are moving towards, we must understand the process we are following today.

LINEAR VALUE CHAIN

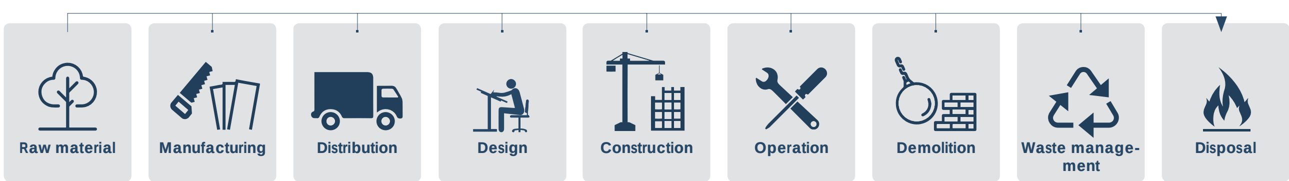
The traditional value chain is linear. Every new building is its own, isolated project, unrelated to past or future buildings. Each time a new construction project is commissioned, the necessary virgin resources are provided to meet the project´s unique requirements for price, function and aesthetics. Thus, the material selection and extraction is guided by economic and architectural considerations for the individual building.

Today, the buildings value chain can be characterized by actors that are particularly specialized and concentrated around a single link in the value chain. Their entire business model is built around this one competence, and their involvement in the construction follows this one function. This includes material recovery, distribution for demolition and waste management. The graphic below illustrates a traditional value chain in the built environment, where, for example, architects handle the design phase and entrepreneurs are responsible for the execution. After the construction of a building we move on to the operating phase, where developers handle the operation until the building has served its purpose and will be demolished. At this stage, demolishers, as well as recycling and waste stations, put and end to the building materials life cycle.

CICRULAR VALUE CHAIN

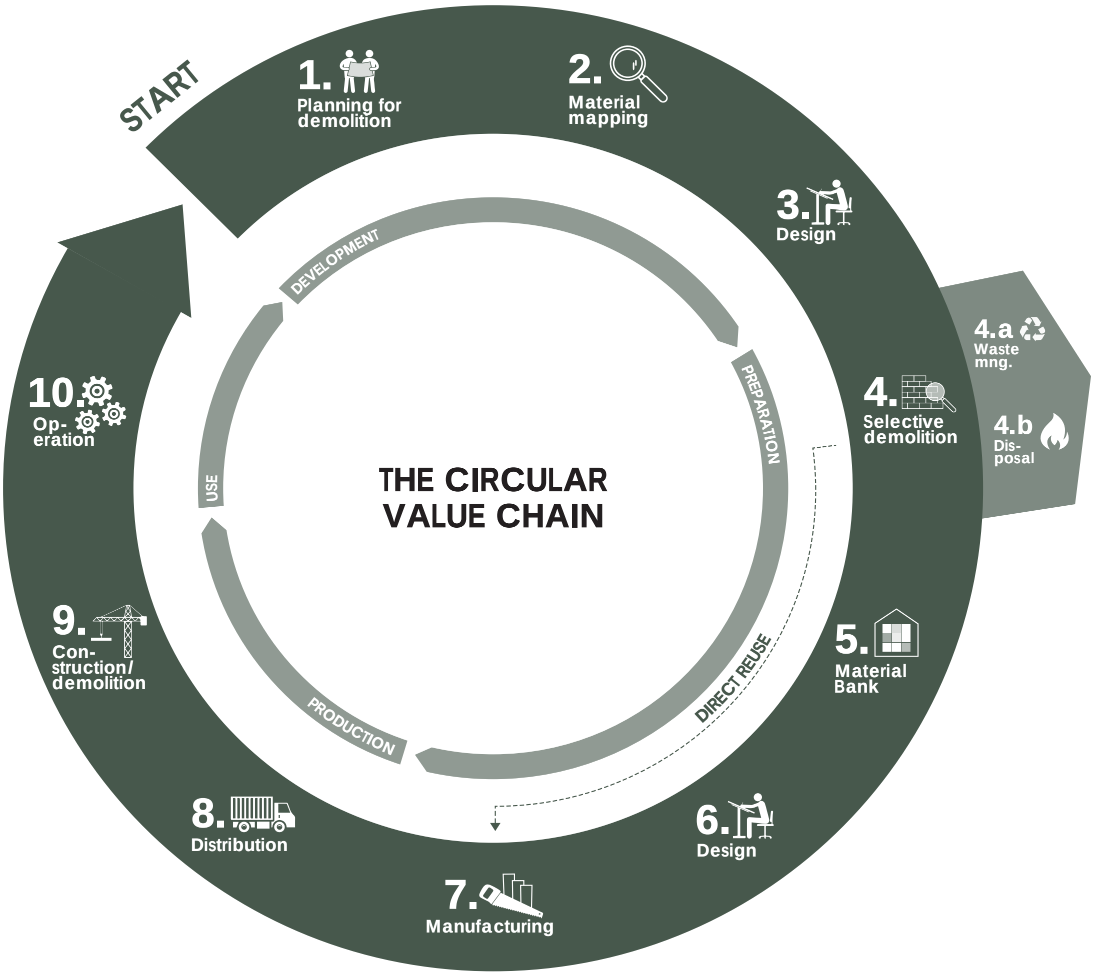
In the circular value chain, each actor should still adhere to its profession. However, the individual actor's professionalism must be used in a new way that can create value, both financially and materially. The main difference between the two value chains is that in the circular value chain, decisions are made on the basis of the availability and quality of already existing materials. It requires a change of mindset and business models. It means a more holistic mindset in the value chain, where the actors take on dual roles and influence several of the chain´s many phases.

Linear Value Chain:



* It is essential to point out that the value chain should not be understood as generic 1:1 process for all types of material circulation as projects and circulation processes may vary from time to time, and obstacles will often be encountered during the process.

Circular Value Chain:



ACTIONS FOR EACH STEP

Every step towards the circular value chain has a further level of detail that one should pay attention to concerning how materials are collected, stored and transported; who collects the materials, who is responsible for the good process and how this is achieved, how to secure as clean and strongly circulated materials as possible, designing materials for new life etc. This type of detail depends on context, purpose, partners and much more. It can therefore only be clarified when the team is set and the purpose of the circulation and the individual material is determined.

THE CIRCULAR VALUE CHAIN

This resource mapping and idea catalogue are supplements to the many other initiatives Göteborg Stad has engaged in, in order to build fossil free. Göteborg is today leading the way towards sustainable construction, as we move from ideas and research to actual execution, where quantifiable impact is observed. Following is a detailing of the different steps to be expected in a circular construction process:

1 Planlægning af nedrivning

A comprehensive plan is drawn for buildings and projects that may need to be renovated, demolished and built. This is done through obtaining an overview of material supply and demand with regard to available materials and possible new construction/ renovation, where circulation of materials can be taken into considerations.

2 Materiale-kortlægning

Once an overview of buildings and projects has been created, the available materials are mapped to obtain a concrete insight into the quantity of the materials with potential for circulation.

3 Design

Based on the mapped materials, materials are selected for further design and conceptualisation. By doing so, materials will be designed with the aim of maximising circulation. Eg. holes for windows and concrete recipes are developed with a focus on a high amount of reusable grants.

4 Selektiv nedriving — 4A Avfallsbeh. — 4B Sluttbeh.

Once the uses of materials are determined, they are collected and gently disassembled from their individual elements. A small proportion of the materials will possibly be sent to final treatment as waste if it is considered to be in too poor condition for circulation.

5 Materiale-bank

A storage warehouse for the collected materials is determined, so that the materials are protected during the demolition and up until treatment and later mounting into new buildings. The storage should/can work as register for available materials and can be internal.

6 Design

The design of buildings and building materials is finally adapted to the knowledge of material supply as it can change after selective demolition and storage.

7 Fremstilling

Based on the design, the collected materials are processed and upcycled for their new purpose. This is done in collaboration with selected material manufacturers and can be done at the construction site, at a specialized factory or a combination of both. An example is concrete that can be mixed and casted at the construction site, avoiding the transport of reusable aggregate and new concrete element.

8 Distribution

Upcycle materials are packed and transported to the construction site – if materials are not manufactured on site. It is important to optimize transportation and packaging to lower expenses and ensure materials sustainability.

9 Nybyg/ renovering

The materials are used in the construction industry, where attention should be paid to any new forms of construction technology in the terms of molding, mounting etc. Here all forms of building materials and any treatment as well as harvesting site of the materials should be registered for the purpose of facilitating future circulation.

10 Drift

As soon as a building is put into use, it should become a direct part of the planning in step 1. By doing so, you know from the very beginning when the building will provide, as well as receive, circular materials in renovation.

NEXT STEPS

RESOURCE MAPPING

With this resource mapping we have gained insight into the inherent values and potentials of the buildings in Kyrkogata 3, 7 and 9, and Biskopgatan 8 in Göteborg – both materially, in terms of potential CO_2 savings and output-amount. The opportunities are interesting.

By turning the four existing buildings into one sustainable children institution, a lot of potential arises. With a varied selection of materials, there are some exciting opportunities for material circulation – from both an economic, environmental and aesthetic perspective.

FOCUSED EFFORT

Circulation of building materials demand a focused effort. Already today, there are several existing examples of circulated materials and it is important to build on already developed knowledge about different materials' capacity, potential, harvesting possibilities etc. The results of this mapping provides an opportunity to prioritise efforts based on knowledge of material types, CO_2 embeddedness and potential output materials.

NEXT STEPS

The next steps will be defining the opportunities in terms of impact. These steps should not be surprising and are often a part of regular construction processes. That being said, these steps are also often neglected when times get busy and budgets are stretched. As circulation of building materials is still a new thing in construction, these processes are very important to ensure end quality, impact and avoid materials being ruined during demolition, degraded due to rain or frost or downcycled due to limitation of time. See recommendations for next steps in box below.

We hope that this resource mapping will help give a feeling of the potentials for circulation based on an insight in specific materials present in the buildings ready for demolition.

We look very much forward to taking this mapping of potentials to concrete action supporting you in realising your ambitious visions of a fossil free city.

CLEAR GOALS AND OBJECTIVES

To ensure that ambitions lead to concrete impact it is important to set clear goals for the circulation of materials. This can be done through dogmas that can serve as measurable objectives and mutual commitments across volume, material type, waste mitigation, visibility and quality of circulation,

SELECTION OF ADVISORS

Too many times we have seen developers with high ambitions having to fight with advisors who do not understand the value of circular construction. When selecting advisors it is of high importance to align expectations and clarify that this construction will not be business as usual and that it is important that they are willing to learn while doing. This is especially relevant for demolishers and contractors who have a high impact on the treatment of existing materials and the selection of "new" materials.

CO-CREATING PROCESS

To succeed when circulating new building materials, it is important that the selected project team is collaborating closely. To create a platform for co-creation it is important to outline a clear process from the beginning that lays the foundations for knowledge sharing and coordination across efforts and priorities.

PRIORITIES IN PLACE

When working in a relatively new space it is important to prioritise in efforts to ensure quick wins and make room for learning meanwhile. Therefore, we recommend to focus on a few impactful solutions to begin with and then be ready to continue to role out when success has been achieved.

RESPONSIBILITY FOR CIRCULATION

It should be clarified how the chosen materials for circulation are more specifically harvested (selective demolition), treated, transported and mounted and, just as important, who is responsible for each process.

FURTHER DEVELOPMENT AND INNOVATION

This mapping is meant to inspire and should not make you feel limited by the ideas presented here. Many other ideas can be viable and materials can be included - eg. based on other sites.