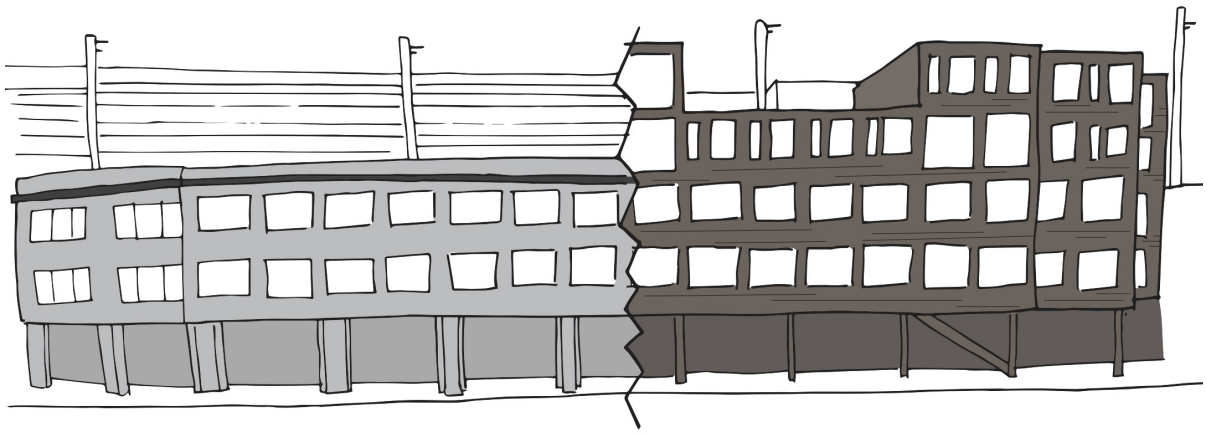
TRANSFORM THE PAST TO LIVE IN A BETTER FUTURE

Renovation of a former centre of education in Brussels into a new social hub



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Department of Architecture and Civil Engineering

Examiner – Liane Thuvander
Supervisor – Walter Unterrainer

Image front page : Before/after

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Renovation of a former education centre in Brussels into a new social hub

Chloé Poisseroux

Gothenburg, SWEDEN
Master Thesis Spring semester 2021
Chalmers University of Technology
Department of Architecture and Civil Engineering
Master Program of Architecture Planning Beyond Sustainability
Direction of Building Design for Sustainability

Examiner – Liane Thuvander
Supervisor – Walter Unterrainer

CHALMERS
UNIVERSITY OF TECHNOLOGY

ABSTRACT

"Transform the past to live in a better future" is about a vision of how a vacant building can be transformed into something that is needed and appreciated. The thesis deals with the three dimensions of sustainable development, the environmental, social, and economic implemented in a building transformation project. In a city, empty buildings are very common, even despite some laws that encourage the owner to keep their building occupied. The vacant building will deteriorate faster, and its area is lost. Some of these infrastructures are old and they have very bad energetic performances. The following research aspires to renovate, transform, improve, extend, uplift a building constructed in 1958. The site is very challenging. It is located in the urban fabric in Brussels, in a noisy area due to the proximity to a railway, which also prevents the possibility of crossed-ventilation and limits daylight to penetrate inside. It is also next to the city centre, and well connected to many places thanks to public transports, there is also a university campus nearby. Social sustainability is addressed with the choice of the new program inside the building. The program has been defined according to the needs of the community around and what the building could offer to improve its surroundings, as it is located in a municipality with a bad reputation. This master thesis was realized in a way that this transformation could be real, it was important that the new program would also assure some financial stability. If someone invests in a vacant building, the person has to be sure he/she could get something out of it. The economical interest is treated by reusing existing resources, and also by better use of the plot. To enhance its potential, a new lightweight structure of two stories has been added on top of the existing construction. Finally, the environmental aspect is covered up by a general upgrade with environmental-friendly materials.

CONTENTS

STUDENT BACKGROUND

My name is Chloé Poisseroux, I come from Belgium and I am 23 years old.

Academic background:

Bachelor's degree in architecture
UCLouvain – Brussels, Belgium
2016 – 2019

MSc. in Architecture, Planning Beyond Sustainability
Chalmers University of Technology
Gothenburg, Sweden
2019 - 2021

Studios at Chalmers:

Planning and design for a sustainable development in a local context
Co-housing, renovation, mixed generations
Sustainable architecture design
Natural materials, different users, ZEB
Future vision for healthcare: housing for elderly
Context, normal life, nature

Personal motivation:

After my bachelor's degree in Belgium, I decided to move to Sweden to study for my master's in order to increase my knowledge about sustainable architecture. I have developed a deep interest in a "respectful" architecture integrating the different dimensions of sustainable development. The environmental, but also the social and economic impact of architecture is at the heart of my concerns.
Present and future generations are facing multiple and complex challenges: population growth, climate change, unsustainable consumption and production patterns, depletion of natural resources, prevention of pandemics such as COVID 19, etc...
As an architect and citizen, I want to believe in a city of tomorrow designed with aesthetics and ethics, with respect for people and nature.
This master thesis aims to tackle some of those challenges dealing with a shortage of housing while an important part of the building stock is left empty.

ACKNOWLEDGEMENT

I would like to deeply thanks the ones who support me during this long process of writing a master thesis.
First of all, I want to express my gratitude to my supervisor Walter Unterrainer, who guided me with his expertise to conduct this thesis in the best way possible, and for his devotion and reactivity to help me. I would also like to thanks Liane Thuvander my examiner, who gave me very interesting feedback.
During this period my friends also inspired me with their work and their advice. I want to thanks my family who helped and supported me during this whole master experience.
And finally, I am grateful to Sander Vander Linden who took his time to make me visit the building in Brussels and shared with me the documentation needed to pursue the analysis.

GLOSSARY

Renovation: the process of repairing and improving a building so that it is in good condition again, or the improvements that are carried out. (Cambridge Business English Dictionary, N.D.)
Restore: to return something or someone to an earlier good condition or position. (Cambridge Business English Dictionary, N.D.)
Refurbishment: work such as painting, repairing, and cleaning that is done to make a building look new again. (Cambridge Business English Dictionary, N.D.)
Embodied Energy: or "embedded energy," is a concept that includes the energy required to extract raw materials from nature, plus the energy utilized in the manufacturing activities. (Kapur-Graedel, 2004)

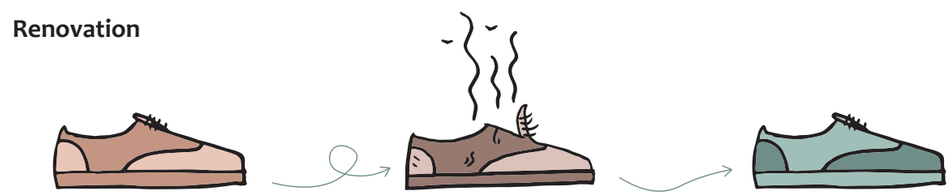

Figure 1. Drawing explaining the differences between Renovation/Restore/Refurbishment

The greenest building is the one
that is already built.
– Carl Elefante

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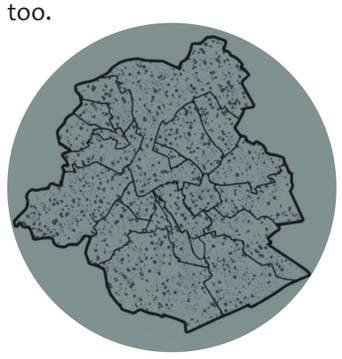
– Introduction –

BACKGROUND

We are living in a world of constant change. Concerns about many aspects of sustainability are rising and the rehabilitation of vacant buildings can play an important role from a perspective of sustainable development. To begin with, there is a modern paradox that opposes the housing crisis with over 4.000 homeless people in Brussels in 2018 (La Starda, 2019) and the important number of unoccupied buildings. In Brussels, there are 6,5 million m² of empty buildings (RTBF, 2019) and to highlight this figure, associations gathered to create the "20th municipality of Brussels". It is made of those millions of m² that correspond to the area of a municipality in Brussels. Re-affect the empty buildings could partially help this social crisis. Renovate those buildings also has an environmental impact. Renovate homes has been more common in the past years. Nevertheless, the European Union states that the annual renovation rate of the building stock is from 0,4 to 1,2% in the Member States and that this number has to at least double to achieve energy efficiency and climate objectives (Mulvaney, 2019). "In Europe, 11% existing building stock undergoes some level of renovation each year" (European Commission, 2020) going from smaller transformation, like changing the kitchen to more important like insulating the building's envelope. However, bigger scale buildings are less renovated though they have more resources to be used and a bigger footprint. Their transformation should decrease the CO_2 emission as instead of building brand new the existing structures could be reused limiting the need for new resources. Moreover, focusing on existing buildings is also a way to limit the exploitation of new land. Indeed, buildings tend to be overspread and consume more and more of nature's territory. The extension of the building site implies also extending the electricity, energy, and transport network using more resources and energy. The existing buildings may have been built a while ago, therefore, they are probably not adapted to today's norm, renovate them could help to reduce their current need for energy and then their climate impact too.



In this map of Brussels, every black dot symbolizes an empty building. All of them together represent the "20th municipality". It is called Saint-Vide-Leegbeek, "vide" and "leeg" meaning "empty" respectively in French and Dutch. (Saint-Vide-Leegbeek, n.d.).

Figure 2. Map of Brussels (Saint-Vide-Leegbeek)

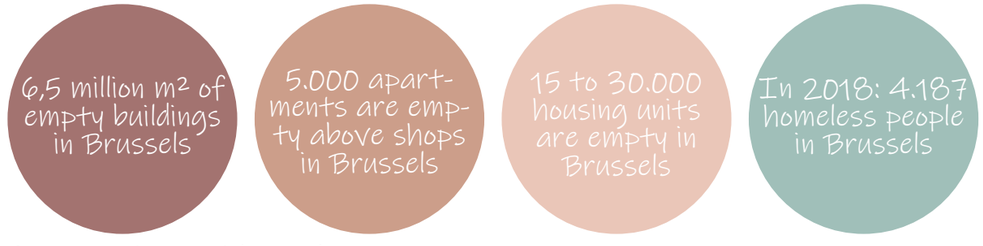


Figure 3. Facts about Brussels (Communa)

With a broader perspective regarding those vacant buildings, the European Commission has launched several projects.
There is one called Second Chance in collaboration with Belgium, Croatia, France, Germany, Italy, Poland, Portugal, Slovenia, Spain, and the UK. Second chance - Waking up the sleeping giants aims to rehabilitate those empty buildings with a new program based on an analysis of the community's needs. It was carried out from 2015 to 2018 with a total budget of 750.000€ with the specific objective of "improving the capacity of cities to manage sustainable urban policies and practices in an integrated and participative way" (Keep EU & European Union., n.d.).
They also initiated, in 2007, a project in partnership with Belgium, Denmark, Germany, the Netherlands, Sweden, and the UK, called SEEDS (Stimulating Enterprising Environments for Development and Sustainability). It aims to support "temporary use and reuse of abandoned buildings and spaces" (European Commission, 2018). It tackles the issues of poverty and social exclusion. The project was completed in 2017 with "a high success rate results-wise" (The North Sea Region Programme, n.d.).

PURPOSE

The purpose of this master thesis is to explore the potential of vacant buildings regarding environmental, social, and economic sustainability. It showcases the improvements done to the building in relation to the environmental aspect thanks to a better envelope composition. It presents an example of such transformation done to a scale to document the possibility to build it. It offers a new program for the site, the extension densifies it and may give financial benefit for retrofitting the whole.

RESEARCH QUESTIONS

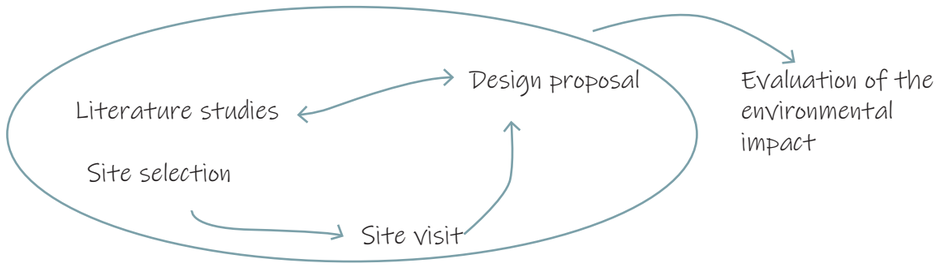
- How can the transformation of an existing building help to reduce the present/future mankind's footprint by the reuse of the building and make it more environment-friendly?
- How can architecture socially support a neighbourhood?
  - In an urban context, how can a building influence people's behaviour?
  - In a very dense area, can the creation of a social hub and housing improve the general feeling in a neighbourhood?

AUDIENCE

This master thesis aims to be accessible for everyone, however it focuses on architects as they would have the main role in this process, it can also be of interest for building contractors, inspire property owners/managers to renovate their own places.

METHOD

The method selected for this master thesis is based on scheme research for and through design. It started with literature on renovation, studies of renovation, examples I could learn from. I pursued with a pre-selection of different sites all of them located in Belgium for two main reasons. Choosing a site in Belgium would be easier to understand the language and I would still be able to visit it. Based on specific criteria, I elected one building to work with. I visited the site, collected information about its history and surroundings. The final step of this master thesis is a renovation design proposal of the chosen site and an analysis of its environmental impact thanks to software such as PHPP (Passive House Planning Package).
In the "real world", the architect has a vested interest in working with residents and potential users so that the project meets the needs, desires, and dreams of the population. In the absence of having been able to listen to users in the definition of the project, this thesis studies the potential synergies between the potential users, however, limited to a theoretical framework. Facilities that do not yet exist in the neighbourhood are also taken into account.



DELIMITATIONS

As the final design proposal site is located in Brussels the transformation is specific to this context. However, thanks to a modular plan, similar renovation could easily be replicated somewhere else so are the details. The choice of the building was also linked to the desire to work with a building of a larger scale. The added elements are mainly reused or natural materials. This added structure is not calculated precisely but the dimensions are based on plausibility.

READING INSTRUCTIONS

During the reading, different steps will be addressed. Firstly, some examples of what has already been made are presented, afterward, a contextualization of the building, its site, and surroundings are developed. In the second part, a design proposal based on the previous parts is presented, further on this proposal will be analysed under the scope of environmental sustainability. And finally, a conclusion and reflections inspired by the process are set forth.

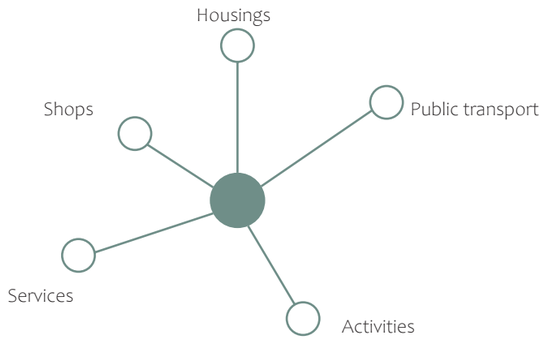
SITE SELECTION

I did a first pre-selection of different vacant buildings located in Belgium. I sorted them with some specific criteria, such as the location/surroundings, the size of the building, its condition, the documentation that I have on it, and a personal judgment. As I also wanted to consider with the social perspective, I had a preference for buildings located in the urban fabric, it was also important for me to choose a building that was bigger than the usual for renovation.

Scale

The size of the building should be bigger than the "norm". But it has to be adapted to the framework of a master thesis.

Location



It should be inserted in the urban fabric to be connected to social life.

Condition

It is a vacant building that should be renovated. It is weakened but not totally damaged to fit in the time allotted for a master thesis.

Figure 4. Criteria site selection

SITE SELECTION

	Location	Condition of the building	Size of the building(s)	Typology	Documentation (plans/sections)	Personal feeling
 **Figure 5.** Middle School Girls - Liège (Marie & Raphael)	Located in the urban fabric, no parks in the surroundings but close to many activities, close to main roads/train station/bus stop.	Not good shape, would need a lot of work to renovate it.	Medium could be sufficient but cannot host many different activities.	Empty schools may be a common typology, in the future maybe schools will have to be different to adapt to pandemics, the existing ones may be obsolete, and they will have to be transformed.	Never received an answer.	Interesting architecture Final grade 8/10
 **Figure 6.** Coal Mine of Hasard de Cheratte - Liège (Grotevriendelijkereus)	Not close to an urban centre, access from a national road.	Bad condition, lot of work to make it ok, asbestos problem (being fix by the current owner as the inside vegetation being removed).	Great size, possibility to have different activities and maybe add new buildings if needed.	There are some mines but not that much in the future that will have to be transformed.	Never received an answer.	Great potential through a lot of work Final grade 7/10
 **Figure 7.** Train station Florennes Central - Philippeville (Quistwater)	Located in a small village, in front: fields, behind: cemetery, close to bus stops but still a bit in the middle of nowhere.	Apparent outside good shape.	Small.	Common. Possible application of the transformation of other stations.	Never received an answer.	Mitigate Final grade 6/10
 **Figure 8.** Swimming pool Solvay - Charleroi (Jmh20)	Close to villages, different activities in the surroundings, close to bus stops/to a national road, a lot of nature/ fields behind.	Not good shape.	Size ok, particularity with the plan (swimming pool).	Swimming pools are common but as this one is quite old, the plan is not common.	Documentation received.	Mitigate Final grade 6/10
 **Figure 9.** Sanatorium of Borgoumont - Liège (Marie & Raphael)	In the middle of nowhere but surrounded by nature, nice orientation.	Not good shape.	Medium, could be sufficient but can not host many different activities.	Not really common.	Never received an answer.	Beautiful landscape Final grade 6/10

	Location	Condition of the building	Size of the building(s)	Typology	Documentation (plans/sections)	Personal feeling
 **Figure 10.** Engineering barracks - Jambes (Lorent, V.)	Great location, close to a city centre but still in contact with nature, in front of a bus stop, close to different activities, behind a river.	Should be good as it was still occupied a year ago.	Really big infrastructure: 400 housings planned for the future.	Unusual buildings, hard to reproduced somewhere else.	Documentation received.	Strong asset with the location. Final grade 8/10
 **Figure 11.** Red Castle - Tihange (Urbex)	Not really good location, a bit secluded.	Outside ok, inside really bad.	Not really big.	Castle can be common to renovate in the future.	Never received an answer.	Interesting architecture Final grade 7/10
 **Figure 12.** Building from train company - Brussels (SNCB)	Good location in Brussels.	Good condition, modular floor.	Big enough to transform the building into an interesting and useful place.	There are a lot of abandoned buildings like that.	Documentation received, visit planned.	It has potential thanks to its plan and location Final grade 8/10
 **Figure 13.** Building from train company - Quévy (SNCB)	Located in a really small village, nature around.	Outside shape looks ok, but there is no information about the inside.	Not really big.	Common, possible application of the conception other stations.	Never received an answer.	Location may be a problem Final grade 6/10

FINAL CHOICE

My final choice was made based on an analysis grid containing various criteria :
- the location, as I prefer to work with a building in the urban fabric,
- the condition of the building, some are in a really deteriorated state,
- its size, offering more opportunities with a bigger one but still being able to manage the transformation within the frame of a master thesis,
- its typology if the transformation can be replicated or not,
- the documentation received, to conduct a project proposal I need the material such as the plans, the sections,
- and finally a personal feeling regarding the building and its site.

Therefore, I decided to choose the building from the train company located in Brussels. There are few aspects that support this choice. This building has a great location, it is in a city, close to many public activities, its area offers a larger array of possibilities.

Rather than being artists of
space, architects need to become
artists of time.
– Stewart Brand

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– Study cases –

STUDY CASES INTRODUCTION

To support and inspire my design proposal, I have looked for different examples of renovation. The first one, the Horsebarn has a focus on the structure. The second one Coop, illustrates the idea that a renovation project can help to revitalise a neighbourhood and should be designed to resist through time. The housings in Copenhagen showcases the improvements made thanks to the renovation and the reborn of the building, the civic centre explains briefly the use of systems inside such as the daylight input and the heat recovery system. The Mima is another example that a renovation project can help a neighbourhood to improve. It is also a conservation and protection of a part of Brussels' history. They can all be classified into one of these categories. The renovation was either made with a long-term perspective, or the building was no longer considered as valuable or it is located in a poor area or the transformation has a social impact on the surroundings.

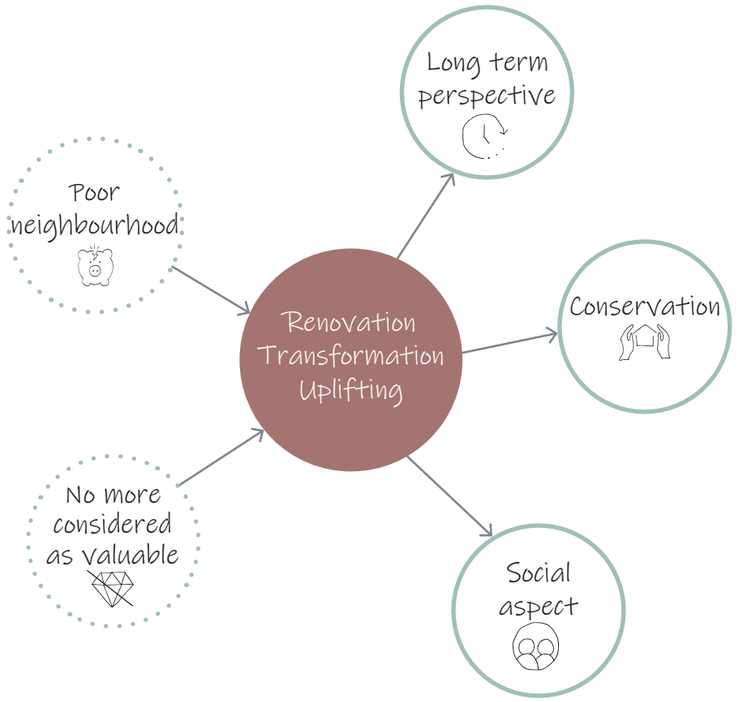

Figure 14. Case study categories

HORSBARN

Figure 15. Horsebarn facade (Frreehill B. & Moore M.)

Figure 16. Horsebarn structure before (Frreehill B. & Moore M.)

Location :
Denver, USA
Architect :
Tres birds
Previous use :
Horse barn
New use :
Office
Date of completion :
2013
Area :
2.787m²
Originally built in :
In the 1800's

The original building was in very poor condition, with challenges linked to the structure, and was saved from demolition. To assure safety without changing the whole skeletons of the building, careful additions to reinforce the structure were designed. To tackle down the energy efficiency aspect, insulation has been added and more efficient windows were placed. One of the focuses was to let the natural daylight penetrates the building as much as possible, increasing the well-being of the workers and decreasing the need for electricity.

Figure 17. Horsebarn structure after (Frreehill B. & Moore M.)

COOP

Figure 18. Coop facade (Eranosian A., Beel L., Ghinitoiu L.)

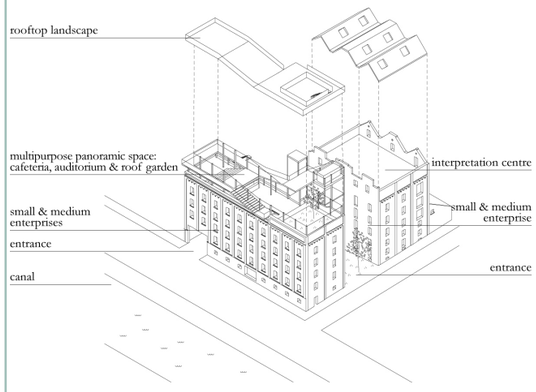

Figure 19. Coop axonometry (Bodgan & Van Broeck)

Location :
Brussels, Belgium
Architect :
Bogdan & Van Broeck
Previous use :
Mill
New use :
Interpretation centre and incubator for small and medium enterprises
Date of completion :
2016
Area :
5.099m²
Originally built in :
1903

The building is located in a poor municipality of Brussels with as mentioned by the architects "local needs for cultural and social sustainability". Therefore, the objective of this transformation was to incorporate a social value, using the building as an engine in the process of improvement of the neighbourhood. The architects also state to have put the focus more on time than on space itself. The reason is to design an evolving building, allowing flexibility and future changes. This transformation had an impact on the neighbourhood, offering it a new reputation and inviting outside people there.

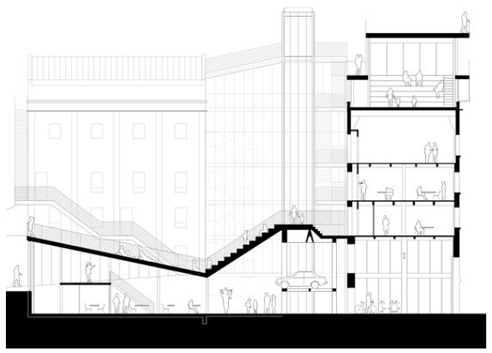

Figure 20. Coop section (Bodgan & Van Broeck)

HOUSING IN KONSTABELSKOLEN

Figure 21. Housing in Konstabelskolen facade (Vandkusten)

Figure 22. Housing in Konstabelskolen facade before (Vandkusten)

Location :
Copenhagen, Denmark
Architect :
Vandkusten
Previous use :
Military school
New use :
Youth housing
Date of completion :
2015
Area :
3.400m²
Originally built in :
1939

After decades of being left empty, the transformation of this building allows to save resources and energy and also preserve an old building. One of the intentions was to keep on exposing the materiality and the history of this building. Hence, the building is insulated from the outside, giving the possibility to show the "raw materials" from the inside. The new larger windows have a double function, they offer more daylight to get in and they also showcase the old brick walls.

Figure 23. Housing in Konstabelskolen structure (Vandkusten)

CIVIC CENTRE

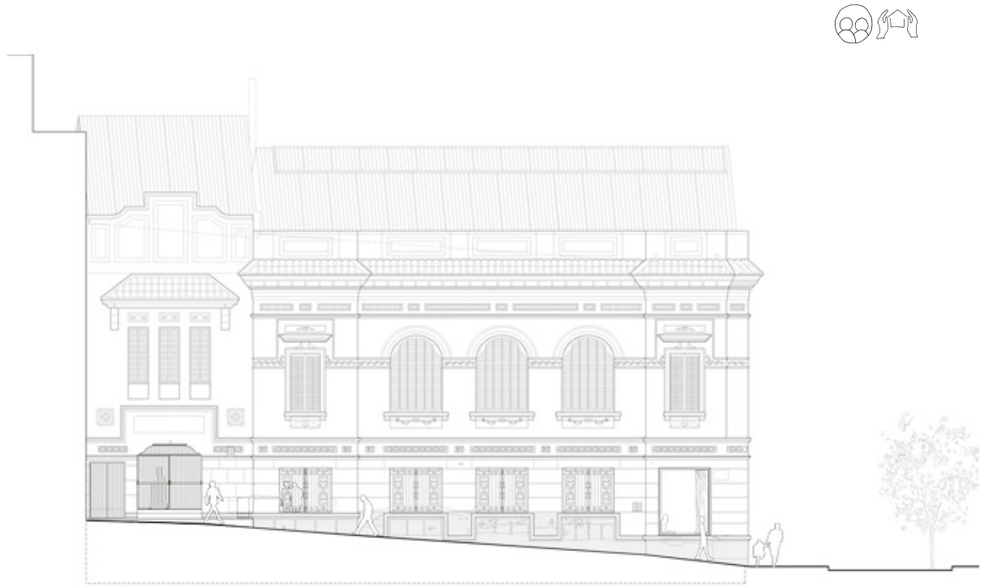

Figure 24. Civic centre facade (Harquitectes)

Figure 25. Civic centre view of the roof (Goula A.)

Location :
Barcelona, Spain
Architect :
Harquitectes
Previous use :
Working-class cooperative
New use :
Commercial
Date of completion :
2017
Area :
1.968m²
Originally built in :
1928

During the transformation process, importance has been given to the understanding of the building and its context. The aims were to use in the best way possible everything that was already existing, enhance the quality of the spaces and propose a sustainable method based on passive strategies. The atrium is designed to bring more daylight inside and it is also regulated to adapt to seasons. In winter heat is collected through a heat recovery system whereas during the summer the hot air is released by the roof ridge windows. Its aesthetic is not defined by making it all new but rather by the dialogue between the old and the new. Aesthetic is brought by the visualization of history.

Figure 26. Civic centre view from inside (Goula A.)

MIMA

Figure 27. Mima view from the canal (Mima)

Figure 28. Mima restaurant (KMarchitectuur)

Location :
Brussels, Belgium
Architect :
A2m
Previous use :
Brewery
New use :
Museum
Date of completion :
2016
Area :
1.269m²
Originally built in :
1916

The Mima museum is located in an industrial area of Brussels. The aim of this project was to unify the two sides of the canal thanks to culture. It is described by the architects as a collective story. The concern was to preserve the envelope as much as possible, with some additions or reparations when needed. Expect for some works on stability, they tried to keep the indoor quite similar also as it has a whole story to tell. Its beauty lies in the roughness and freshness brought with the renovation. The Mima museum is located in Molenbeek, a municipality with a bad reputation. Therefore, the worry was that the museum would not be visited a lot. However, for the opening of the museum, there was a long queue to enter and nowadays, despite the pandemic, the museum has still a lot of success.

Figure 29. Mima entrance (Houba G.)

Renovating old homes is not about making them look new… It is about making new unnecessary.
– Ty Mcbride

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– Context –

DIFFERENT SCALES

CITY SCALE

Figure 30. Map of Belgium

1.211.026 citizens in Brussels-Capital

Density of 7.504 per/km²

Average age of 37 years

Brussels is located in the region of Brussels-Capital in Belgium. It is the politic centre of the European Union. It is composed of 19 municipalities. The main language spoken is French but Dutch and other languages are also spoken to a lesser extent. In 2020, 1.211.026 inhabitants were collated (Registre National, 2020) on an area of 161,38 km² which means a density of 7.504/km².
It is the first employment hub in Belgium with half of the job taken by people coming from outside the city (ICN Stabel, 2020).
The average age in the region of Brussels-Capital is 37 years old (IBSA Stabel, 2019).

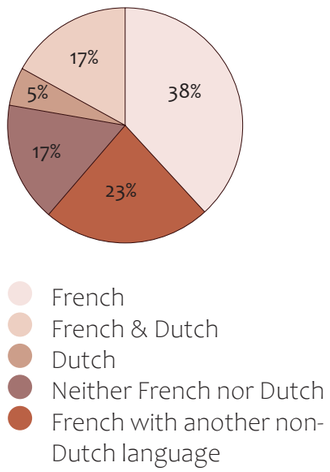


Figure 31. Spoken languages in Brussels-Capital in 2013 (Hooiwind)

MUNICIPALITY SCALE

Figure 32. Map of Brussels

27.497 citizens in Saint-Josse-ten-Noode

Density of 23.358 per/km²

Area of 1,1km²

153 different nationalities & 60+ languages spoken

3x more people by day than by night

The selected building is located in the municipality of Saint-Josse-ten-Noode (SJTN). It is one of the 19 municipalities of Brussels. Its area is only 1,1km² (IBSA, 2020) with 27.497 inhabitants (IBSA, 2020) which makes it the densest municipalities in Brussels. The population is young, the average age is 35 years old, the lowest in Belgium (IBSA, 2020), and multi-cultural with 153 different nationalities and more than 60 languages spoken (IBSA, 2020). However, in the past years, Saint-Josse-ten-Noode has suffered from a bad reputation as a result to its poverty, for instance, the wealth index (Belgium = 100) is only 51 in 2018, whereas it is 78 in Brussels-city (IBSA Stabel, 2018). Nevertheless, the municipality is appreciated for its diversity, with the possibility to find shops with roots from almost everywhere, to meet "European workers, homeless people, senior executives, migrants, artists, and so on" as the municipality of Saint-Josse-ten-Noode writes.

Figure 33. Green area is the delimitation of Saint-Josse-ten-Noode

During the 1950s, old parts of Brussels suffered from a lot of alterations. This phenomenon, called “Bruxellisation” in French, describes the destruction of entire plots of old houses with the aim to modernize the city. Many citizens were forced to evacuate their homes to let companies construct high-rises dedicated to offices and create boulevards crossing the city. It was also at this time that the train junction connecting the city from North to South has been created, wrecking down a part of the city. Due to the economic crisis which occurred in the 70s, many of those skyscrapers projects were not built because the investors could not fund them anymore. Therefore, for decades after, whole plots throughout the city were left empty.
However, now the city wants to invest in the municipalities with more issues, such as Saint-Josse-ten-Noode to improve the life quality and tend to fix some mistakes of the past.

1960’s “Bruxellisation”

1970’s economic crisis

35 years : lowest age rate of Belgium

Railway goes underground

The city wants to invest in the municipalities with more issues

NEIGHBOURHOOD SCALE

Figure 34. Saint-Josse-ten-Noode in 1930-35 (BruGISTeam)

Figure 35. Saint-Josse-ten-Noode in 2019 (BruGISTeam)

Building.
Demolition of the houses on the North-West to build offices instead.
Creation of the train junction which crosses the city.
Preservation of the Botanic garden on the South of the image.

BUILDING SCALE

Figure 36. Building view from the South-East

Built in 1958

Total area of the building 2.286 km²

Concrete structure

Current consumption 499 kwh/m²y (see **Figure 37**)

Modular floor plan

The chosen building is located next to the railway, this one is raised above the ground to allow roads to pass under. Therefore, on both the ground floor and the first floor of the West side, there is no possibility to place windows. The building has been erected in 1958, it has always belonged to the Belgian railway company. It was used as an education centre until 2016, after it has been used as a "shelter" for the construction site next to it. It is left empty since 2018. The building structure is made of a concrete columns/ beams system allowing freedom in the plans. Thanks to its structure it is very resistant. It also provides the possibility to largely open up the East facade. By partially covering up the pavement, the building offers protection for pedestrians. In 2006, the windows have been replaced with double glazed ones, the radiators have also been changed and some work was done on the roof. According to the energy performance certificate, the current consumption is 499kWh/m²y (see **Figure 37**), as a reference, a passive building has to be under 15kWh/m²y, and now in Brussels, every renovation project has to be less than 100kWh/m²y primary energy(Bruxelles Environnement, 2019).

ENERGY PERFORMANCE CERTIFICATE

CERTIFICAT DE PERFORMANCE ENERGETIQUE

Région de Bruxelles-Capitale

Ce document fournit des informations utiles sur la performance énergétique du bâtiment (PEB). Des explications et informations complémentaires plus détaillées figurent dans les pages suivantes.

Rue de Brabant, 23
1210, Bruxelles

Immeuble sans Commerces
Superficie : 1.712 m²

Certificat valide jusqu'au : 20/05/2030

1 Performance énergétique du bâtiment

Très économe

< 62 A
62 - 155 B
156 - 248 C
249 - 341 D
342 - 434 E
435 - 527 F
> 527 G

Très énergivore

Performance énergétique moyenne en Région de Bruxelles-Capitale

F

Consommation par m² [$kWh_{EP}/m^2/an$]	499
Consommation totale [kWh_{EP}/an]	854.166

2 Emissions CO_2

Emissions annuelles de CO_2 par m² (kg CO_2/ m²/an)

PEU — BEAUCOUP

104

Figure 37. PEB certificate (Verelst B.)

The energy performance certificate was undertaken in May 2020. This document is needed for every new building, for sale or rent building in the region of Brussels-Capital. The results are terrible, the building consumes 499kWh/m² (primary energy) every year, the average in the region of Brussels-Capital for building with a similar use is between 249 and 434 kWh/m²y. Those very bad results can be explained by different reasons, the building is not (or barely) insulated, neither the walls, nor the roof or slabs. The windows on the ground floor are not efficient at all and the heating system is quite old and consumes a lot of energy. According to the recommendations, replacing the boiler and the burner could save up to 15% of the heating installation (See appendix A).

SWOT ANALYSIS NEIGHBOURHOOD

Strength

Lots of housings around
Close to the city centre
Green spaces nearby
Easy access to public transport

Opportunity

Active population
Under transformation
Diversity of nationality
Increase of population

Weakness

Many offices in the surroundings = empty at night
Railway dividing the neighbourhood

Threat

Bad reputation
Increase of population

Figure 38. Map of the strength and opportunity

Figure 39. Map of the weakness and threat

As can be seen in those pictures, the facade to the street is full of waste, the windows have bars to keep distance from the street. Inside, degradations can also be observed on the walls. The staircase has a pleasant design with plenty of daylight, especially on the last floor.
All the pictures without reference are mine.

Figure 40. View from the North-East

Figure 41. View from the pedestrian pathway

Figure 42. View from the train station on the North-West

Figure 43. View on the shop from the pedestrian pathway

Figure 44. View from inside

Figure 45. View from inside

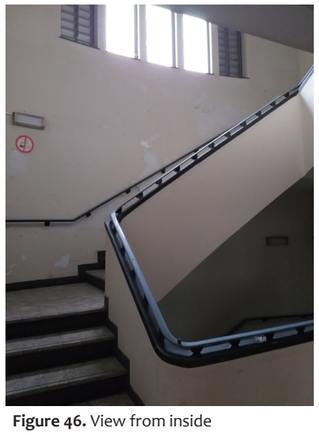


Figure 46. View from inside

The greatest challenge to any thinker
is stating the problem in a way that
will allow a solution.
– Bertrand Russell

4

– Design proposal –

THE ORIGINAL BUILDING

The original building was constructed in 1958. The grid of the concrete structure is 6m x 3,8m. On the ground floor, the footprint is smaller to let room for the sidewalk. On the upper floor, the building is extended on the East increasing its area and covering up the sidewalk.
There is one main staircase in the middle of the building and another smaller that leads to the basement with the heating system.
On the West side of the building, 6 rectangles are drawn representing the structure that supports the railway. Still, on the West, there are also some indentions in the building that serves for the poles supporting the railway's catenaries.
On the East, the pedestrian pathway is covered up by the building.

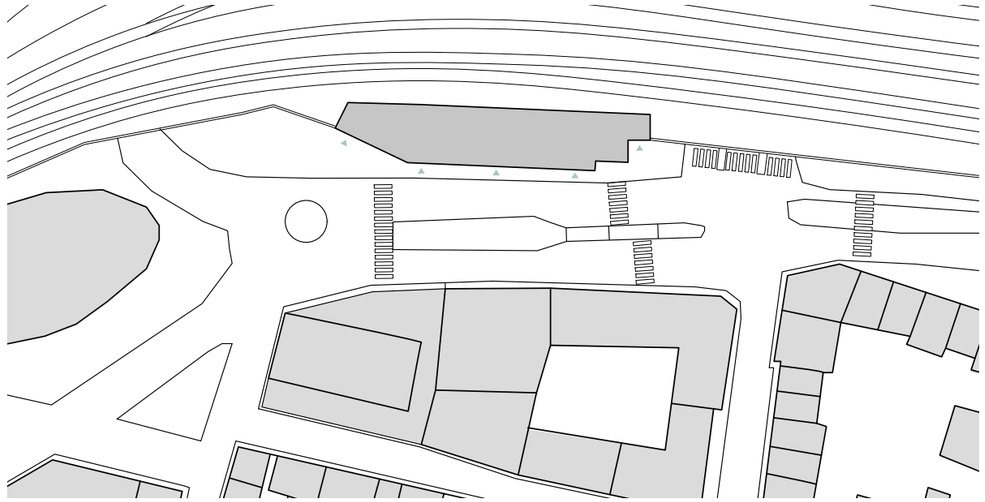


Figure 48. Site plan

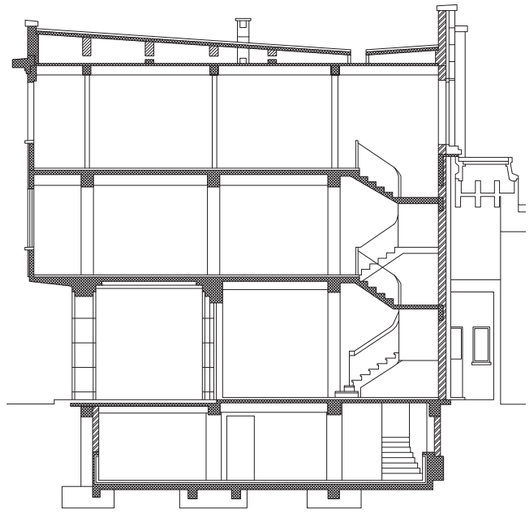


Figure 47. Section East-West

0m 2,5m 5m

PLANS

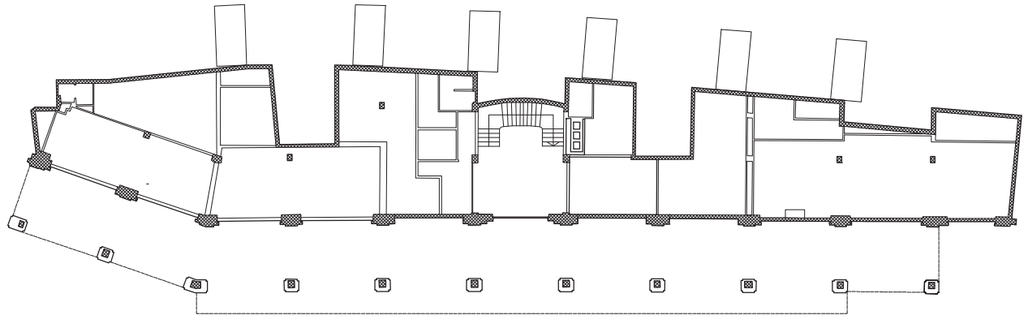


Figure 49. Ground floor

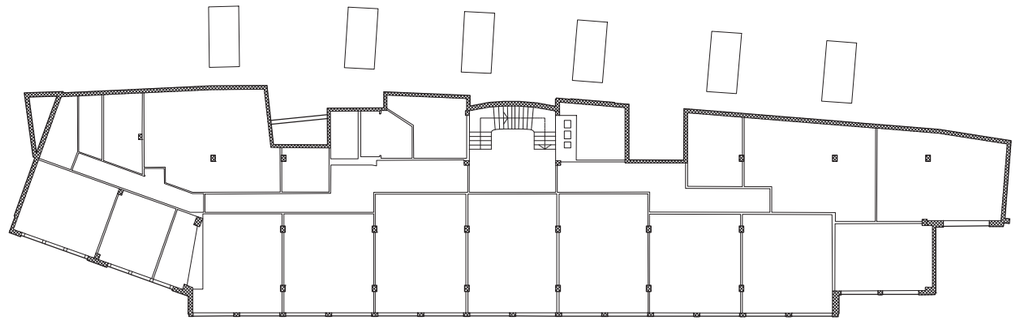


Figure 50. First floor

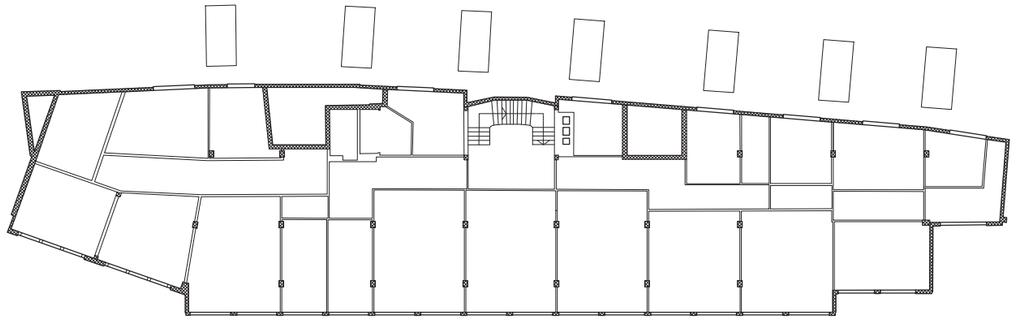


Figure 51. Second floor

N>

0m 5m 10m

RAILWAY

The building is directly in contact with the railway which is raised to the second floor so at some specifics points it is possible to have a road crossing underneath. Therefore, on the ground and the first floor it is not possible to get any daylight from the West side. This is why two atria have been created.

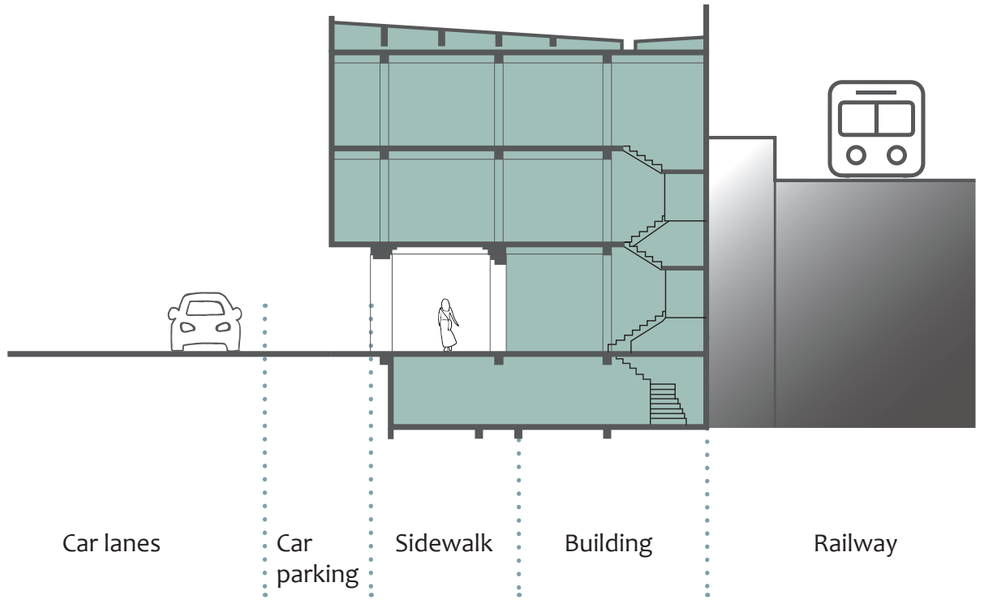
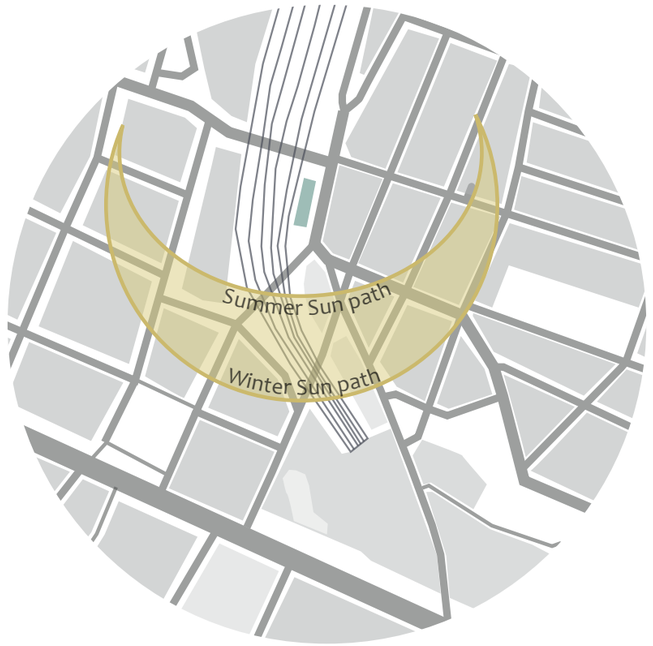


Figure 54. Building conceptual section East-west

SUN STUDY



On the South, the sunlight is obstructed by some high-rises.
On the West side thanks to the distance created by the railway of about 70m, natural light can penetrate the upper section building easier. As there are many windows, due to the function inside, on the Eastern and Western facade, a strategy to protect from overheating is designed. The windows will be equipped with shutters.

Figure 55. Sun path based on data retrived from SunCalc

FUNCTIONS

As the building is located in a city, many services can be found in the surroundings such as restaurants, theatre, pubs, shops and so on. A university and the botanic garden can also be perceived on this map.

Figure 56. Services around

DESIGN STRATEGY

The program
Behind the new program of the building lies a deeper reflection. Neither the municipality nor the new owner has clear planning for this building. Therefore, functions have been chosen according to the area. The program was defined with the aim to revitalize not only the building but also the area which tends to feel insecure. One of the main concerns also was that the new functions take into account the economic aspect and a necessary return on investment for the owner.
These are the reasons why on the ground floor, there is a restaurant and a co-working space. Those functions have also been thought to work with their surrounding. A major train station is located next to the building which entails a lot of travellers and commuters to come and go. Therefore, the need for a place to rest, and eat, and time permitted work.
The Wallonia-Brussels Federation recognizes a significant deficit in childcare places in the Brussels region. A new nursery, therefore, fulfils a real need. (Daily Science Brussels, 2020, September 23). Alternatively to a nursery, a recreational and exchanges centre made up of play modules reconciling leisure, pleasure, and psycho-motor skills could be considered. This space dedicated to parents and children would be open not only to families but also to schools for fun or learning activities. For this alternative, a global revision of the space dedicated to the function would then be expected.
A gym is also contemplated on the first floor of the building, the area around is dense in housing so it will easily find clients.
A paramedical centre, that serves both the economic and the social aspects, is located on the second floor. It is aimed at helping the kids with difficulties around with a focus on kids from 2 to 18 years old with motor or psychological deficiencies. The centre can help them to adapt to a new situation, it also has a role in re-education or guides the patient to feel better. More information about the different specialists in the centre can be found in appendix B.
To optimise the use of the plot, two stories of a lightweight structure have been added to the existing one. It is dedicated to 16 student housings. It was decided that it would be for students for a few reasons. First, a university campus is located within walking distance (10min walking) which makes it attractive for students. Second, the closeness with the train station is also a big asset as most of them go home during the weekend. This proximity with the railway strengthens the idea of student housing as it is temporary housing.
Mixing housing and public functions is intended to maintain actively the area throughout the day, therefore, increasing the feeling of security. This program was also selected to work together to create synergies within the building.
As the ground and the first floor on the West side are deprived of windows, rooms such as computer, technical, sanitary rooms, or a nap room for the nursery are placed on these darker areas.

The railway
To improve the comfort of living in a noisy area, specific strategies have been undertaken. The first one was to create some distance with the railway, this is why the additional structure does not follow the existing building on the West side. The indoor design was also thought to fit with the surroundings. The bedrooms have been placed on the East-side and the circulation is located on the West side to create a buffer zone towards the railway. It was also decided that it would be temporary housing as opposed to permanent housing, regarding the noise issue.

BUILDING

The new version of the building undergoes a whole uplifting process, the existing infrastructure is transformed, extended, up-cycled, renovated.
On these images, this evolution is made visible.
The yellow represents the part of the building that will be demolished, the red is for the parts that will be added.


Existing building

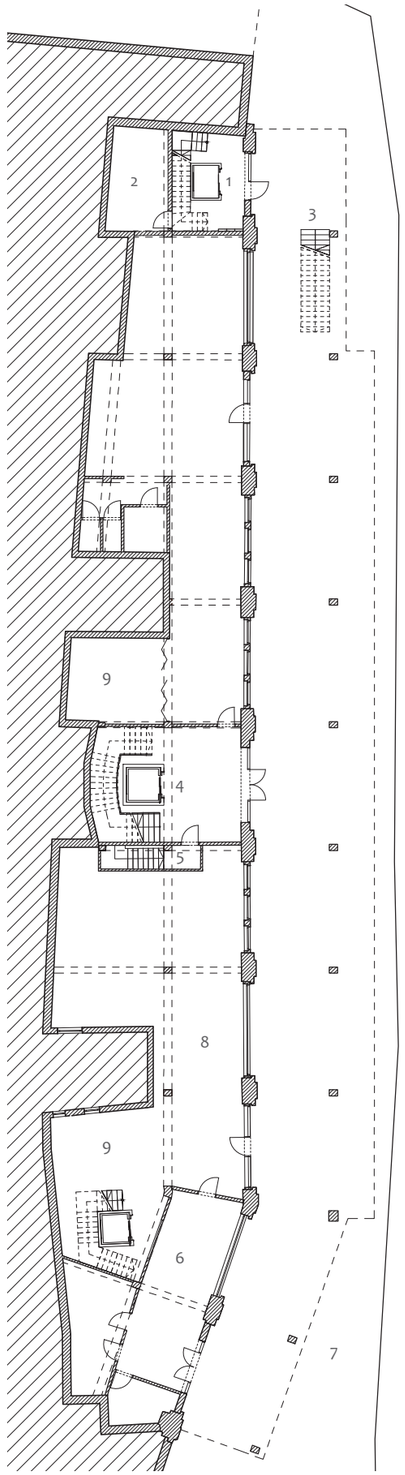

Illustration of changes


New construction plan


Final version

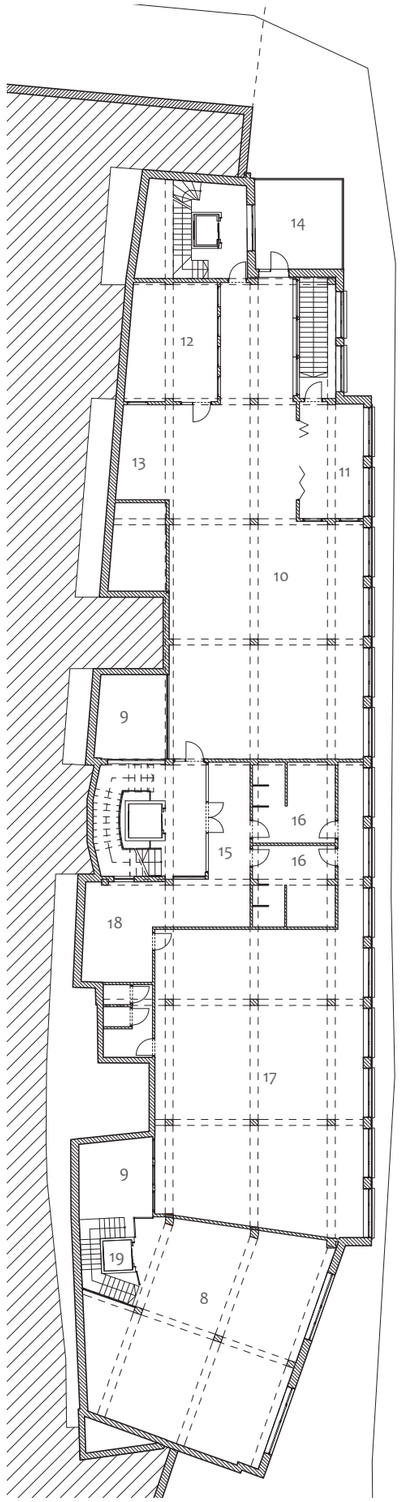
The demolition plan shows that some windows have to be changed to adapt better to the new indoor design, the “coat” of the columns on the ground floor is also removed to let their inner structure appear.
On the new construction plan, it is visible that two new stories have been added on top of the existing construction. A stair going from the street to the first floor is also added to improve the flow of the building.
And to enhance the aspect of the surroundings, a few trees were planted.
The two new stories increase the total net area, excluding the staircases, by 744m² offering 16 apartments of about 40m² for two students with two bedrooms of 14m² and one bathroom. There are also common kitchens and common rooms.
The project provides for the creation of new terraces, for a total area of about 295m².

GROUND FLOOR



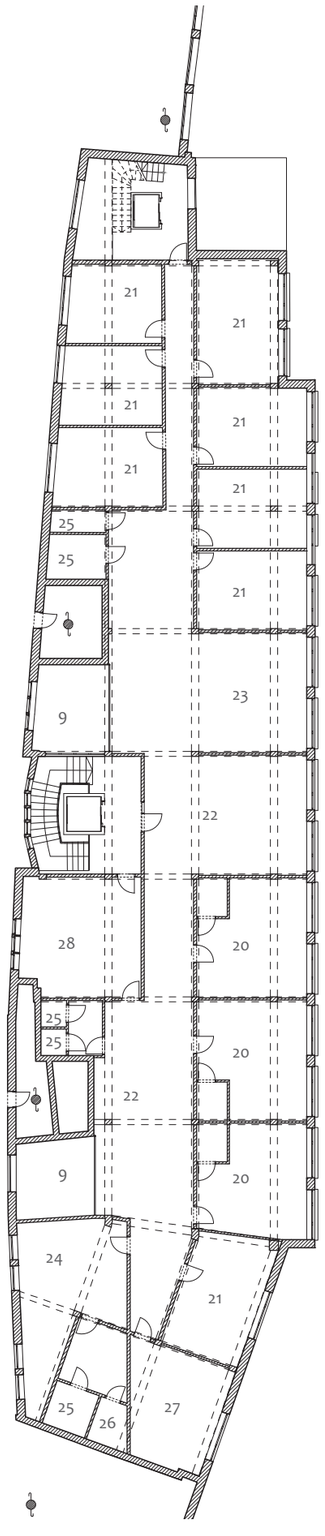
The entrance for the student housings (1), is located on the North part of the ground floor. Behind the vertical circulation is a storage room (2). There are also mailboxes on this floor.
A stair outside (3) gives access to the nursery directly from the street. A second access with an elevator (4) is planned in the centre of the building for those who need or prefer.
Behind the main staircase, there is also a lot of room as the ceiling is quite high, this place could be used to let the stroller during the day for instance.
Another stair (5) gives access to the basement where the heating system is situated.
The restaurant kitchen (6) is placed on the very South part of the building, this exact location has been decided as there is an extension of the pavement (7) which would allow the delivery trucks to park for a temporary moment. The restaurant (8) is located between the main entrance and the kitchen.
As it was mentioned previously, on the ground floor and the first floor there is no possibility to place windows Eastwards. Therefore, to let daylight comes in, two atria were created (9).
The traffic island in front of the building that is in a poor state will be remodelled with more greenery and a clearer limit.

FIRST FLOOR

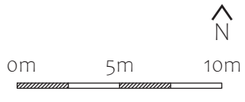


To access the nursery (10) from the street, the outer stair will lead first to a buffer zone (11). The nursery can host till 13 children, this number is calculated according to a rule of 4m²/children for indoor activity space and 2m² for rest area (Office de la Naissance et de l'Enfance, n.d., p.10). A nap room (12) is planned as well as a small kitchen (13) for the staff.
It was also important to give the opportunity to have an outdoor area so a small terrace (14) has been added. For a safety aspect, one door to the student circulation has been added.
At the entrance of the gym (15), there is first a desk to check-in, right after that there are two changing rooms (16) with showers and lockers. The gym (17) spreads on more than 140m². A staff room (18) is connected to the entrance desk. From the gym room, there is a view of the atrium (9) offering more natural light.
On the Southern part of the building, the restaurant (8) extends to the first floor.
To facilitate the flow and for people with limited mobility and waiters, an elevator (19) provides for the connection between the two floors.

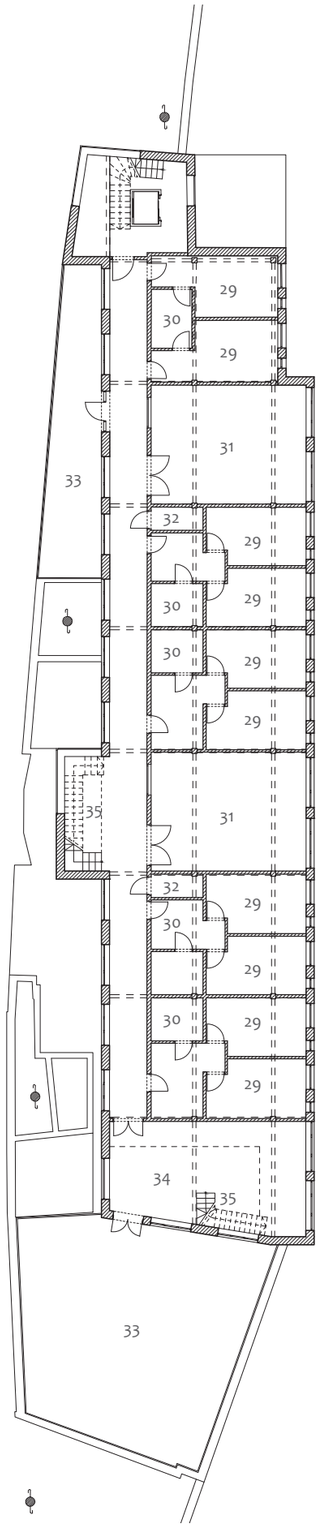
SECOND FLOOR



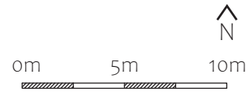
The second floor is entirely dedicated to the para-medical centre. This centre can host 12 different specialists, there are different rooms adapted to the various activities that take place. The motor therapists have more space (20) with an auscultation table and a small changing room.
The psychological therapists (21) have a desk, comfortable chairs, some shelves to store games, folders, books, and material necessary for their consultation. Each room has a large window.
When a patient enters, he/she arrives directly in front of the entrance desk (22). After the person registers his/her presence, the relevant waiting room (23) will be indicated according to the specialist he/she came to see.
On this floor, there is again a door to access the student circulation in case of emergency.
A staff room (24) is located on the South of the building with a toilet (25) and also a shower (26). A meeting room can also be found there (27).
There is also a multi-purpose room (28) for the motor therapists who may need more space.



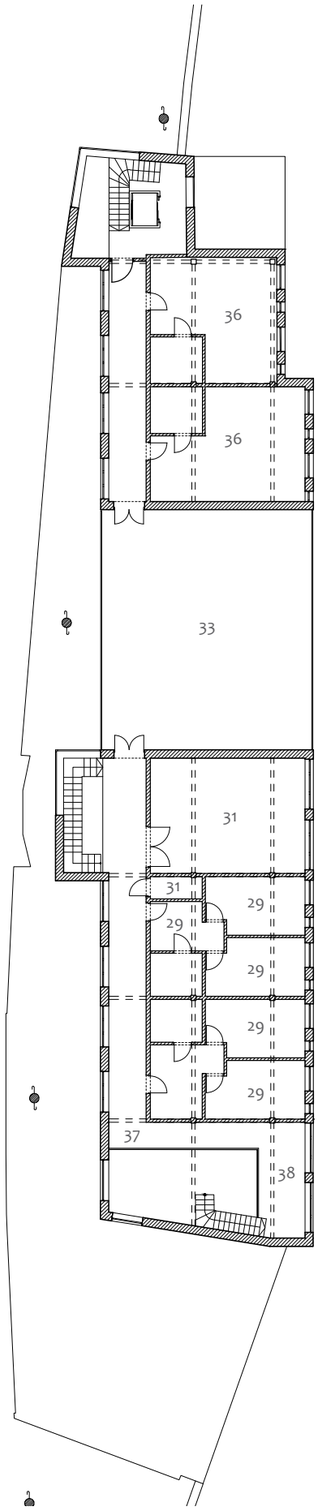
THIRD FLOOR



There are 10 bedrooms (29) of 14m³ on the third floor. They are gathered as cluster of two sharing one bathroom (30). The kitchens (31) are big enough so they can be comfortable for approximately 5 students. There are also two individual toilets (32) out of the private space for easy access from the common spaces.
There are two terraces (33), one is oriented towards the West and the second one is located on the South with a triple orientation.
Connected to the bigger terrace there is a multi-purpose room (34), where a baby-foot, billiard, sofas, and so on can be installed to allow the students to hang out all together.
Two additional stairs (35), one in the middle of the building and one in the multi-purpose room, provide the connection with the last floor.



FOURTH FLOOR



The last floor hosts four similar bedrooms (29), the kitchen (31) and there are also two studios (36), that are a little larger.
There is also a terrace (33) between the two parts.
A gallery (37) is created as the extension of the hallway. The multi-purpose room is principally double-heigh but with a small mezzanine (38) generating a cosier place on the last floor.
The flat roofs that are not used as a terrace are green roofs.

SYNERGIES

This study focused on the synergies between the different functions. Many connections are created within the building itself.
In fact, the students from the housings upstairs can go to the co-working space to study, they can go to the restaurant, to the gym.
In the nursery, it could be observed if a kid experiences difficulties and could therefore be checked in the paramedical centre.
There is a multi-purpose room on the para-medical centre floor that can be used by the motor therapists but it could also be used by the gym to host dance or yoga classes for instance.
The restaurant can also work together with the co-working space.
Those functions were also imagined to fit the needs of the community around, adding services that are missing in the area.

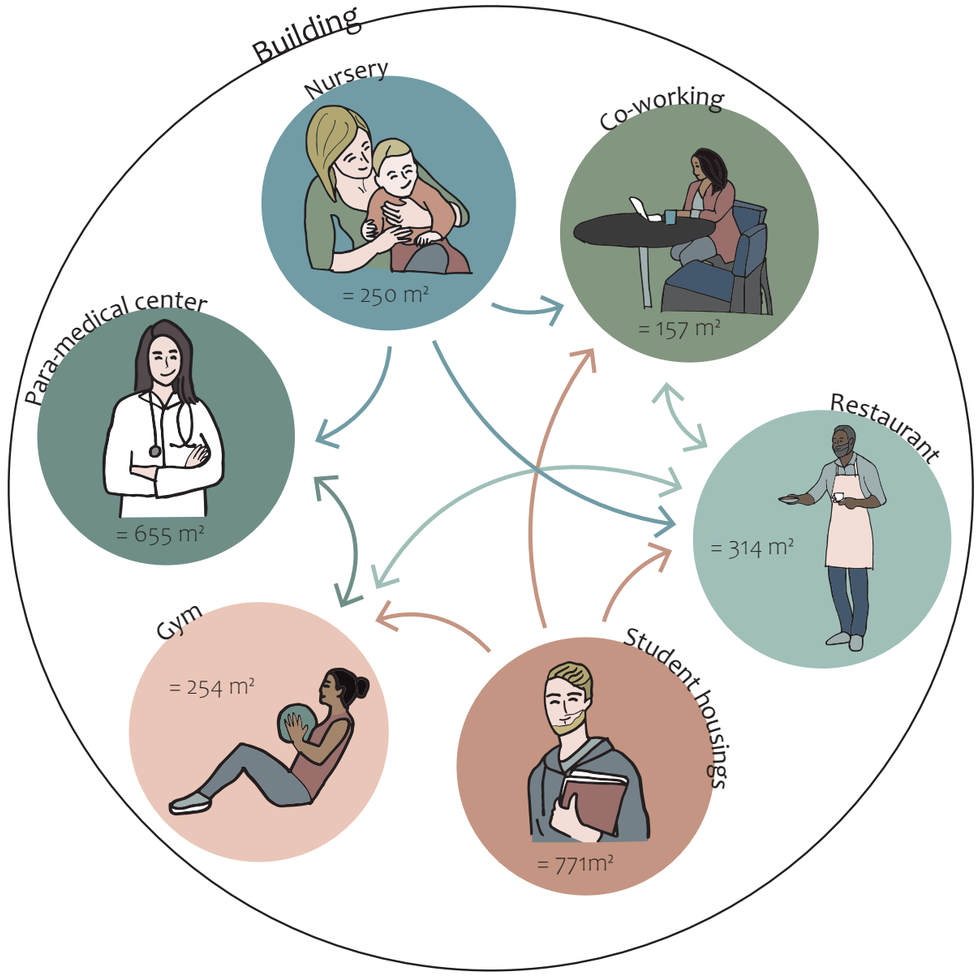
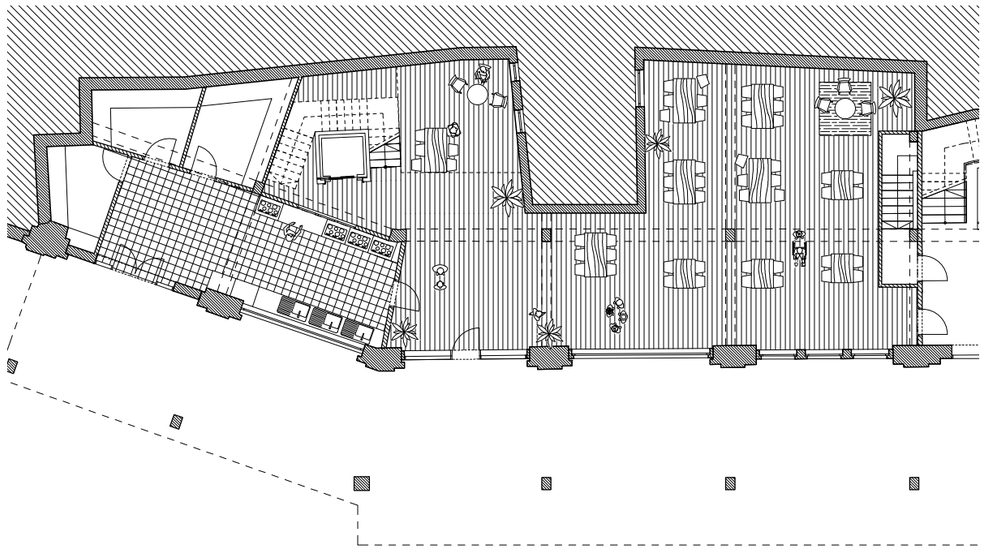
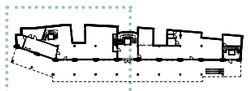


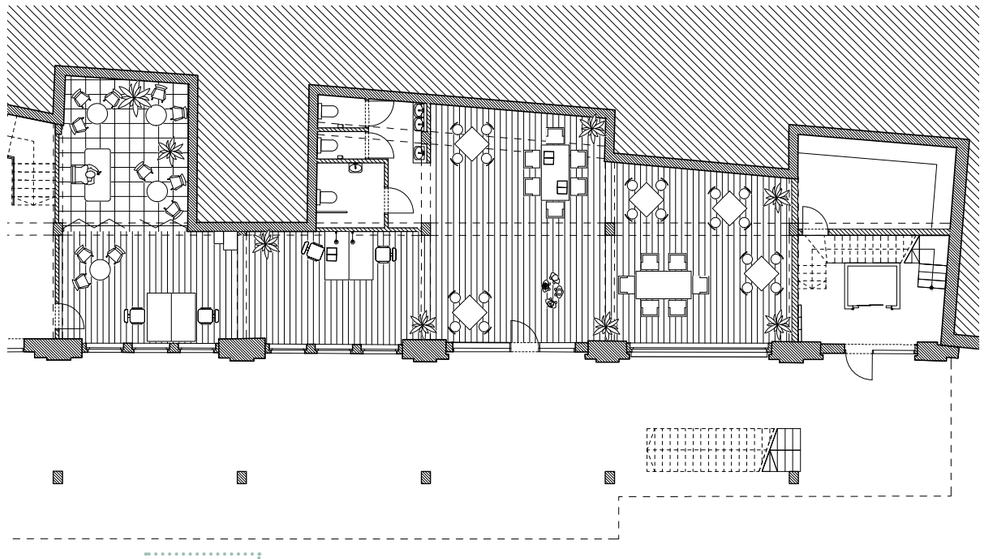
Figure 58. Diagram synergies

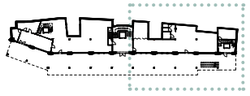
RESTAURANT





CO-WORKING

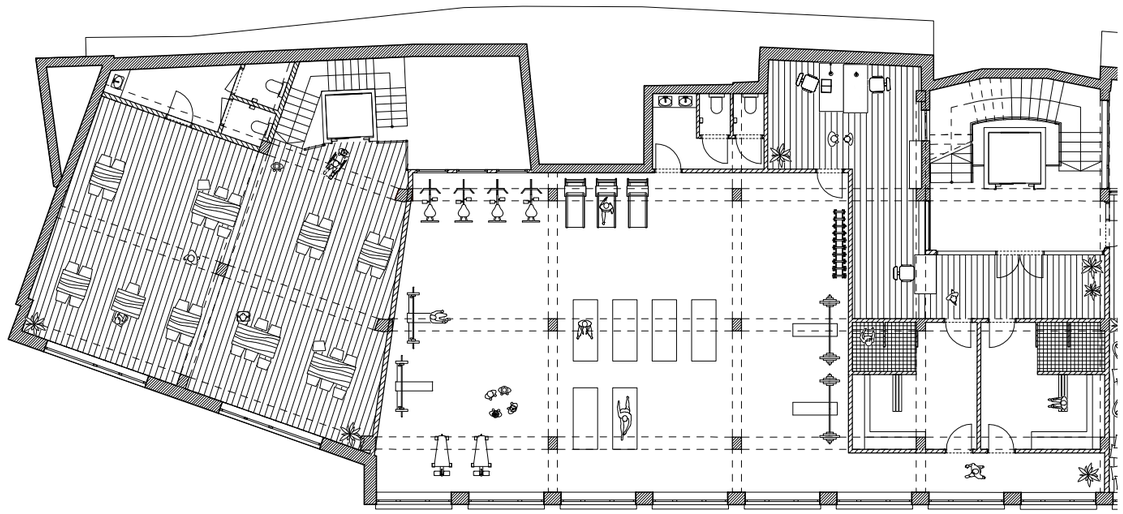




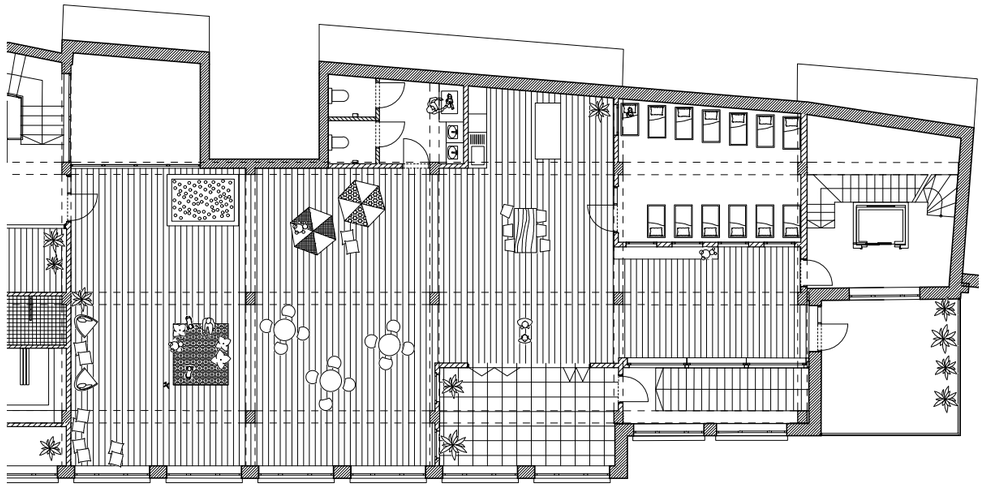
N

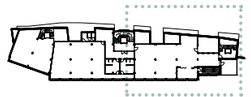
0m 2,5m 5m

RESTAURANT & GYM



NURSERY





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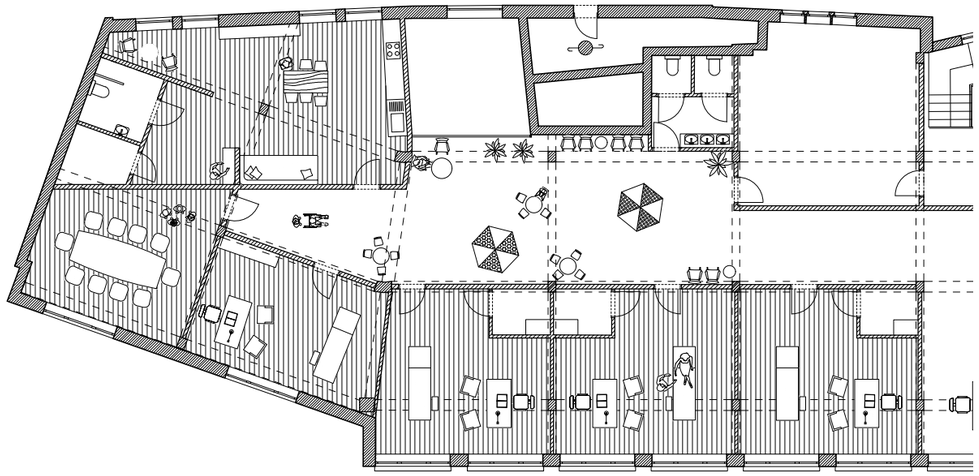
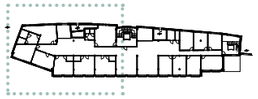
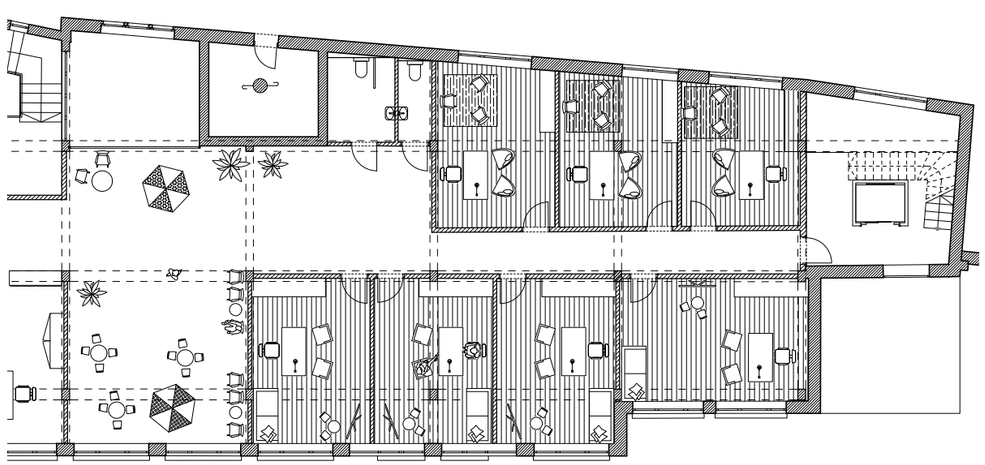
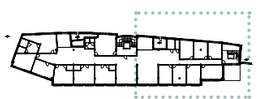
PARAMEDICAL CENTRE





PARAMEDICAL CENTRE





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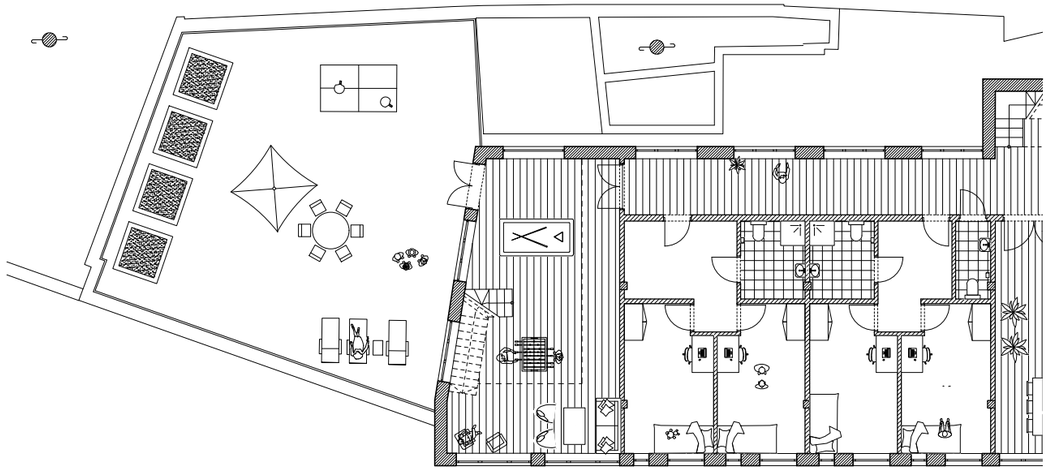
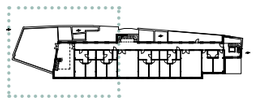
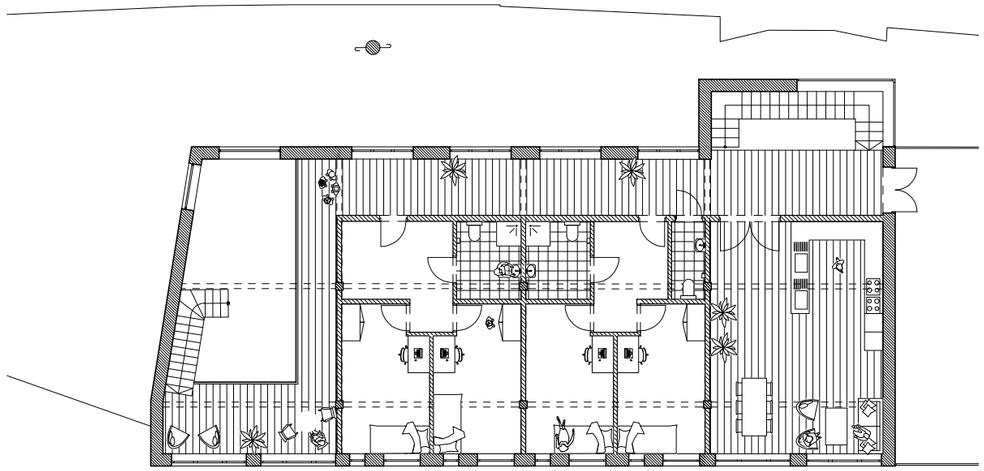
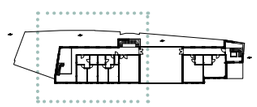
STUDENT HOUSING





STUDENT HOUSING





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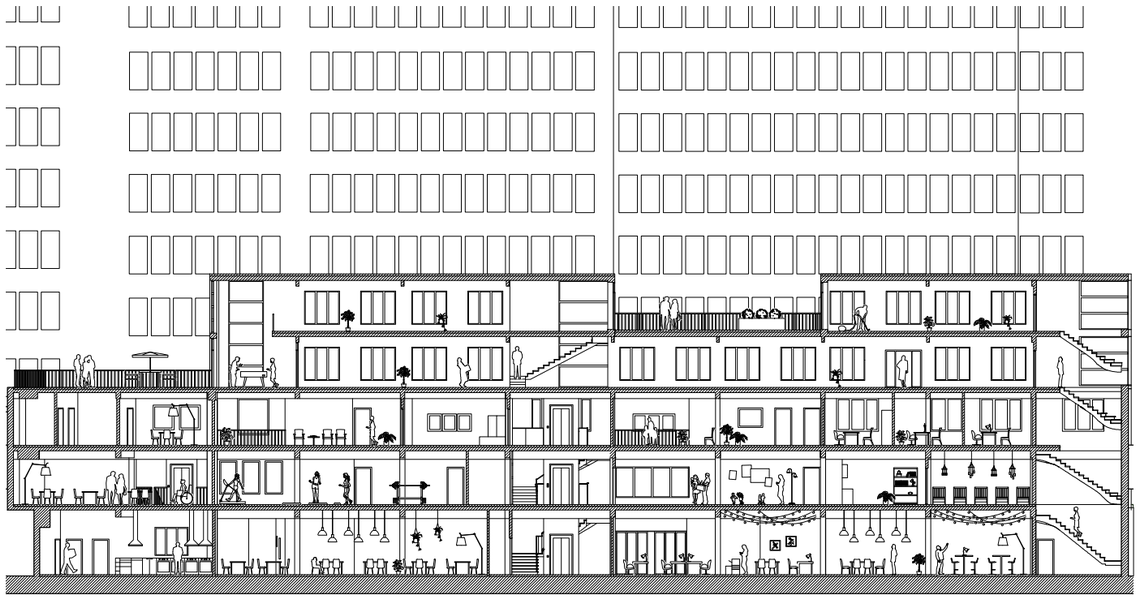
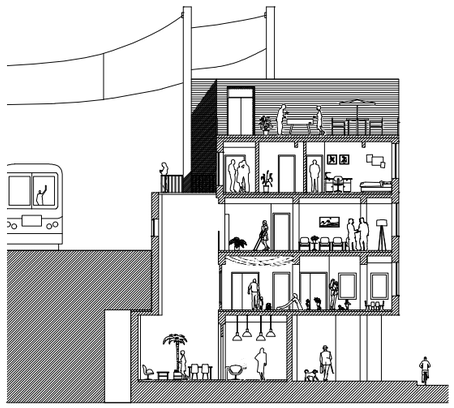
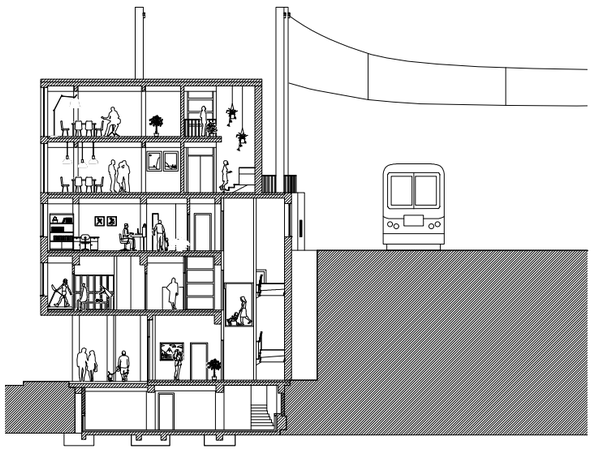
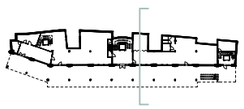
SECTION AA

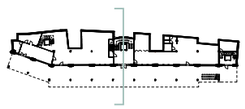


SECTION BB & CC



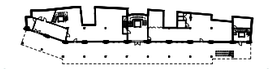




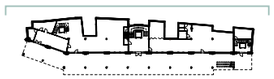


0m 5m 10m

ELEVATION EAST

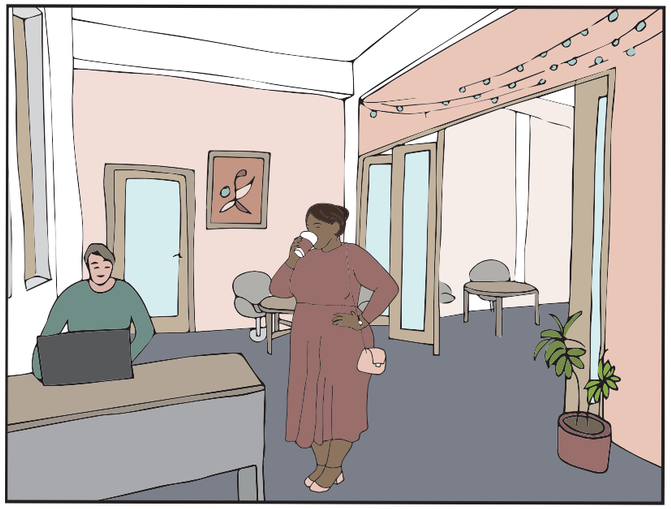


ELEVATION WEST



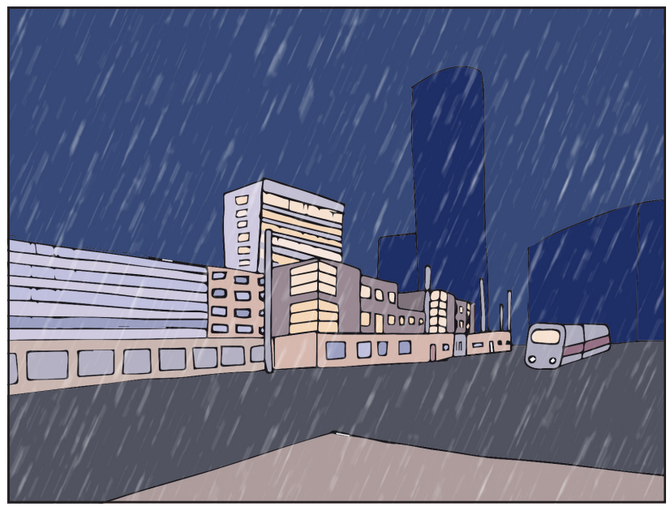
0m 5m 10m

PERSPECTIVE OF THE CO-WORKING



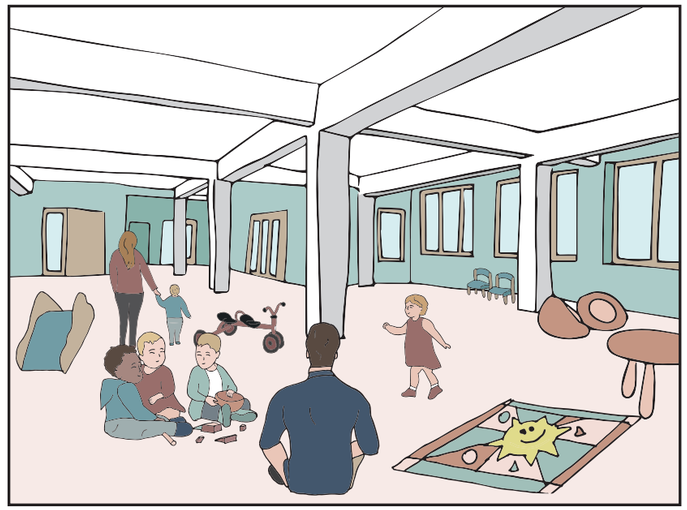
The co-working space can operate in collaboration with the restaurant. It is a comfortable place to work for people waiting for their train for instance. As it is on the ground floor, the atrium is used also for tables. The place offers different atmosphere, to work as group or alone.
There are also printers and computers available.

PERSPECTIVE FROM THE TRAIN STATION



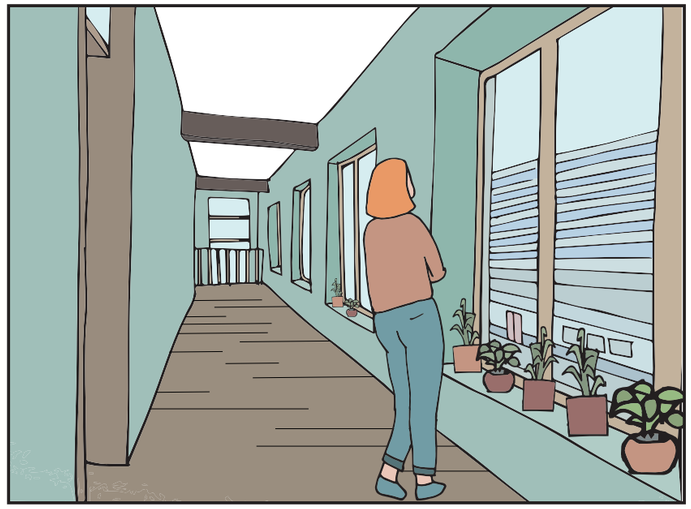
The west facade of the building is visible from the train station nearby. The addition structure in wood can clearly be differentiated from the existing part.

PERSPECTIVE OF THE NURSERY



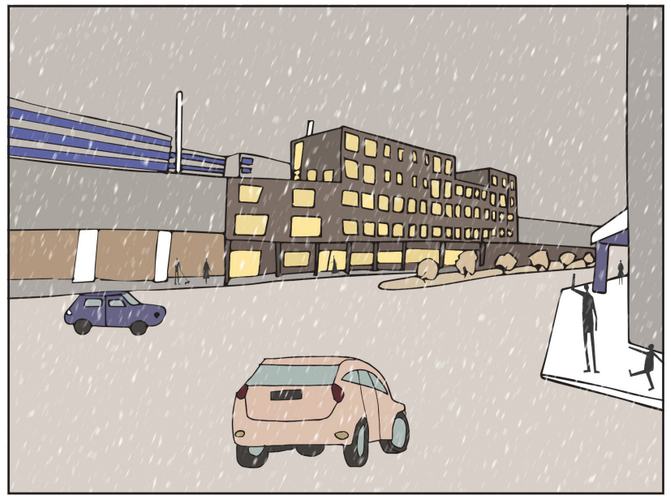
The nursery can be accessed from the street and from inside the building. As there is no possibility to have windows on the Eastern side of the nursery, the layout takes advantage of it by placing the nap room and the bathroom in the blind places.

PERSPECTIVE OF THE STUDENT HALLWAY



The student hallway is located alongside the railway to create a buffer zone to mitigate the noise. In order to make the circulation a pleasant experience, there are many windows opening up on the railway, showing the passage of the trains and lighting up the hall.

PERSPECTIVE FROM THE SOUTH EAST



Coming from the road on the South-East, after a turn in the street, the building is the first one to appear.

PERSPECTIVE FROM THE NORTH EAST

Instead of the concrete panels, the new facade is covered up with a re-used wooden cladding, offering a more welcoming environment for the passengers.

PERSPECTIVE OF THE WAITING ROOM

All the rooms in the paramedical centre have at least one window letting daylight entering however, privacy from the street is preserved, as they are on the second floor.
The professionals have some storage inside of their office.
On the West side there is the multi-purpose room which can be used as an extension if needed.

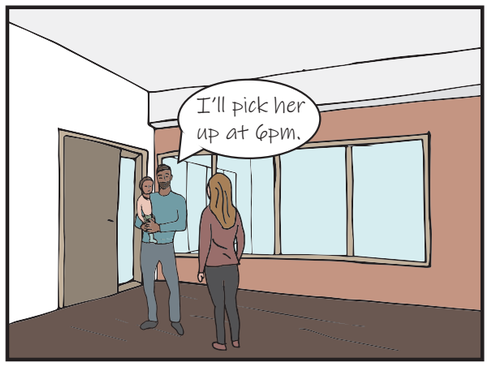
PERSPECTIVE OF THE STUDENT TERRACE

During the long summer evenings, the students appreciate spending time on the main terrace. They can spend hours playing cards, discussing, and so on.

MARVIN'S DAY

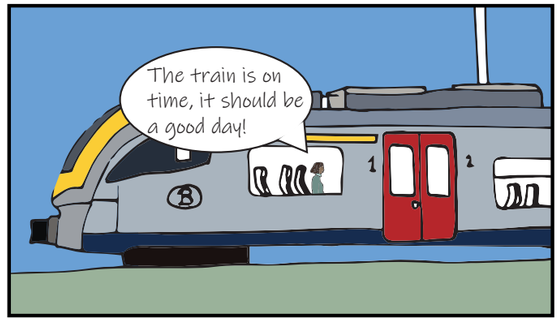
Marvin is 23 years old, he has just moved to the new student apartments. He enjoys the closeness to the city centre and his university. Thanks to the train station next to the building, going back home at weekend is convenient. Sometimes he studies in the co-working space alone or with friends and he goes three times a week to the gym.

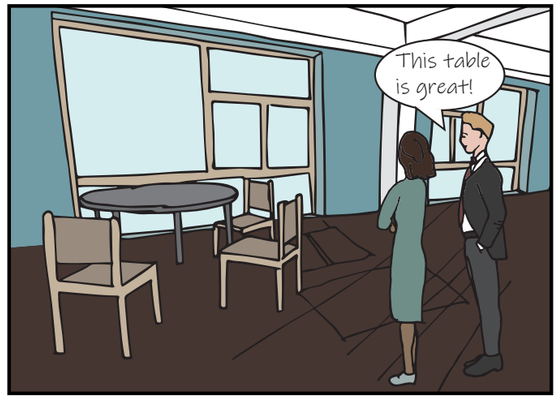
NOAH'S DAY



Noah has lived in the neighbourhood for 3 years. Since the renovation of the building, he is the chef of the restaurant. He loves working there especially thanks to the nursery where he can drop his daughter before starting his day. Sometimes during his break, he goes to play with her.

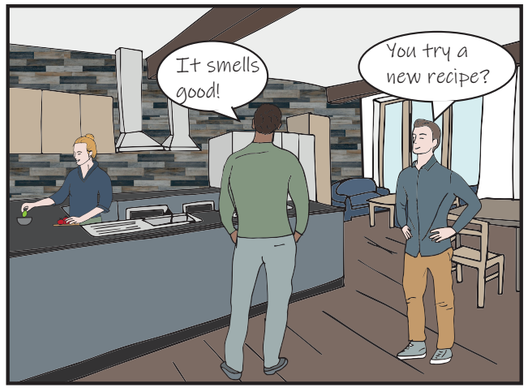
ANNA'S DAY

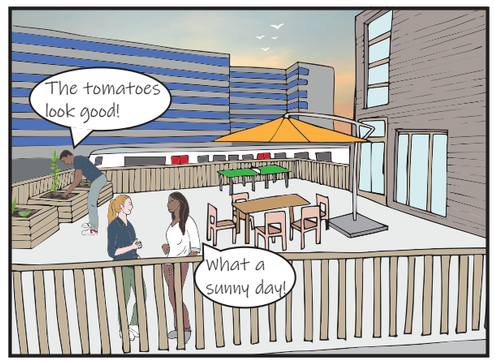




Anna lives just outside Brussels but thanks to the train station nearby her workplace, it is very easy for her to go to work. She is a speech therapist in the para-medical centre. She appreciates working together with colleagues like her. Every third Tuesday of the month she goes to the restaurant with her boyfriend. They love Noah's food.

LEA'S DAY





Lea was one of the first students to move into the new apartments. Her roommate Alice became her best friend and during spring they love spending the afternoon on the terrace. She likes the community life in the apartments. They hang out a lot together, the two of them enjoy cooking. Lea tries often new recipes with her roommate and when she needs something there is always someone to help her.

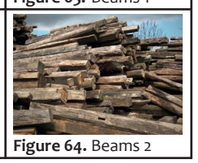
A society is defined not only by
what it creates but what it refuses
to destroy.
– John Sawhill

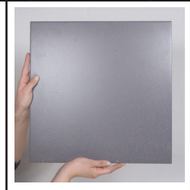
5

– Technical part –

COLUMN, BEAMS, CLADDING, FLOORING

During the transformation process, new materials are needed. Priority is given to reused and local materials as much as possible. To do so, I took advantage of the website Opalis which gathers suppliers of reused materials in Belgium, France, and the Netherlands. They have many elements available, but I focused on the indoor and outdoor cladding, the flooring of the new structure, and on beams and poles that are not load-bearing. For the added structure, new wooden materials have been favoured for safety purposes. On the tab below, various materials are gathered according to their function. I am not going to pick one in particular, but I wanted to make sure that it was possible to find those reused materials.

	Essence	Dimensions	Price	Previous use	Origin	Image
Column	Douglas	15 x15cm x 3-4-5m	49/55/65€	???	Belgium	 **Figure 59.** Columns 1
	Douglas	15 x 15cm x 3m	49,5€/ linear meter	???	Nether-lands	 **Figure 60.** Columns 2
	Oak	10 x 10cm x 3m	45,3€/ linear meter	???	Nether-lands	 **Figure 61.** Columns 3
	Oak	20 x 20cm x 3m	186€/ linear meter	???	Nether-lands	 **Figure 62.** Columns 4
Beams	Oak	10x10 /15x15 / 20x20/ 40x40 x up to 6m	???	Support beams of old barn	Belgium	 **Figure 63.** Beams 1
	Oak	10x10 / 30x30 x 2-6m	???	Old barn beam	Europe	 **Figure 64.** Beams 2

	Essence	Dimensions	Price	Previous use	Origin	Image
Cladding	Oak	17mm x 100-180mm x 1 - 2,6m	79€/m²	Old train	Europe	 **Figure 65.** Cladding 1
	Basralocus	15mm x 70-100-130mm x 3-3,5m	107,02€/m²	Old barn (Europe or Canada)	Canada	 **Figure 66.** Cladding 2
	Fir planks	13-30-50mm x 195-220mm x 1-5m	???	Scaffolding Europe	???	 **Figure 67.** Cladding 3
Flooring	Speckled dark grey porcelain stoneware tiles	400mm x 400mm x 7mm	12€/m²	???	???	 **Figure 68.** Tiles 1
	Speckled light grey ceramic tiles	151mm x 151mm x 15mm	74€/m²	St. Elisabeth Nursing School in Leuven	Belgium	 **Figure 69.** Tiles 2
	Speckled dark grey porcelain stoneware tiles	300mm x 300mm x 6mm	12€/m²	???	???	 **Figure 70.** Tiles 3
	Train car flooring	21mm x width depends on the stock x 400-2200mm	???	Train car flooring	France	 **Figure 71.** Flooring 1
	Train car flooring	20mm x 100-240mm x 1000-2700mm	???	Old barn	???	 **Figure 72.** Flooring 2

INSULATION

Regarding the insulation, I preferred working with a new natural element instead of a reused one in order to assure good quality for the building's energy performances. The insulation materials already on market have usually less efficient performances. To have a clearer vision of what is possible I listed a few insulation elements with their pros and cons.

Insulation	Pros	Cons	Price
Hemp  **Figure 73.** Hemp	+ Fire resistant + Good acoustic property + Moisture-regulating + Store CO_2	- Can not be used in a wet environment	10-25 €/m²
Cork  **Figure 74.** Cork	+ Light weight + Rot/water proof + Fire/termite resistant	- Expensive - Does not grow everywhere - Destructive method to peel it	20-40 €/m²
Cellulose  **Figure 75.** Cellulose	+ Good thermal insulation (0,040 W/mK) + Good acoustic property + Easy to install	- Can not be used in a wet environment - Complicated for renovation?	10-25 €/m²
Wood fibre  **Figure 76.** Wood fibre	+ Good thermal insulation + Moisture-regulating + High heat storage capacity		19-24 €/m²
Sheep's wool  **Figure 77.** Sheep's wool	+ Safe for the environment and user + Regulate humidity + Good acoustic property + Non-flammable + Long-lasting	- Lower thermal efficiency - Needs to be treated against insects & fungi	XX€/m²
Straw  **Figure 78.** Straw	+ The straw used comes from a waste product + Biodegradable + Resistant to fire due to the density + Low embodied energy	- Big thickness - Can not be used in a wet environment - Can irritate skin & lungs during the process	XX€/m²
Foam glass  **Figure 79.** Foamglas	+ Resistant to compression + Water/vapour proof + Incombustible + Unalterable + Ecological + Factory in Belgium	- Very fragile and brittle - Expensive - Heavy	XX€/m²

STEICO FLEX F 036 & FOAMGLAS

Having compared the insulation materials, I decided to use mainly wood fibre for its better results. Therefore, I looked for suppliers in Belgium. A material, in particular, appeared as the best choice. It is a semi-rigid wood fibre panel called Steico flex F 036, there is one factory in France that produces it. It has a very low thermal conductivity (0,036 W/mK) which makes it efficient against heat and cold. It is made out of resinous wood from forests labelled PEFC & FSC. It does not contain any hazardous components, it does not irritate the skin. It is easy to install and can adapt to different shapes. It is also open to the diffusion of water vapour. (Steico, n.d.)

Figure 80. Steico flex F 036 (Steico)

Thermal conductivity :
0,036 W/mK
Density :
+- 55 kg/m³
Components :
Wood fibre, polyolefin fibre, ammonium sulphate
Thickness :
From 40 to 240mm
(Steico, n.d.)

For the roof insulation, I opted for foam glass insulation. This material is very resistant in regard to compression, and therefore quite appropriate for such use. It is also fabricated 70km from the site, it has a low thermal conductivity (0,036 W/mK). It aims to be sustainable, the elements can be reused after their first function as backfill material (Systèmes d'Isolation Pour Les Toitures Plates, n.d.).

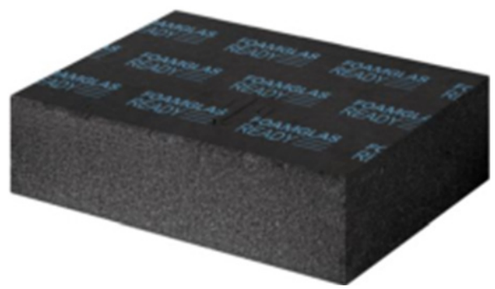
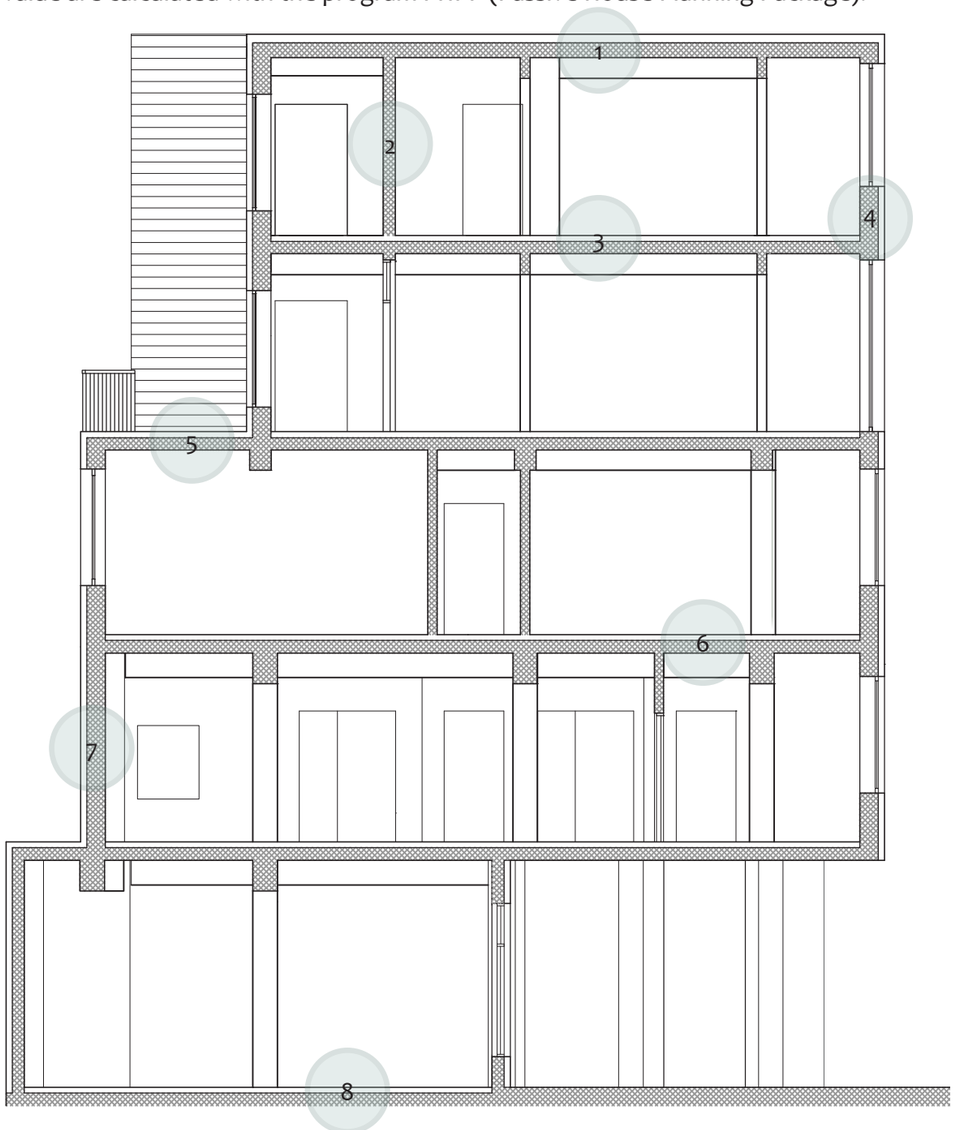


Figure 81. Foamglas® Ready Tapered T3+ (Owens Corning)

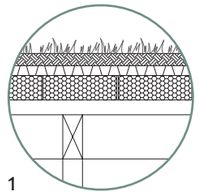
Thermal conductivity :
0,036 W/mK
Density :
100 kg/m³
Components :
Recycled glass (≥ 60%), sand, dolomite, lime
Thickness :
From 60 to 200mm
(Foamglas, 2020)

DETAILS

For the details of the existing building, I had to guess a little as the only plans that exist are quite old and not precise. Therefore, I had to assume partly the composition of the building. In the plan, it is said that the thickness of the outer walls is about 20cm but it is not specified if there is any insulation although it is very unlikely in view of the date of the construction. From the outside, it appears that the facade is covered up with concrete panels.
For the renovation, I imagine removing those panels and insulate from the outside.
The dimension of the added structure is not based on calculation but on plausibility.
The details on the following pages are represented to the scale of 1/20 and the LCA and U-value are calculated with the program PHPP (Passive House Planning Package).

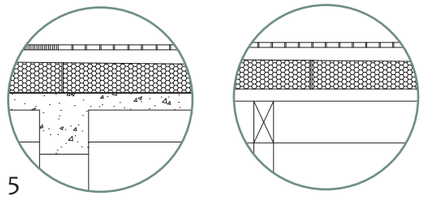


Roof



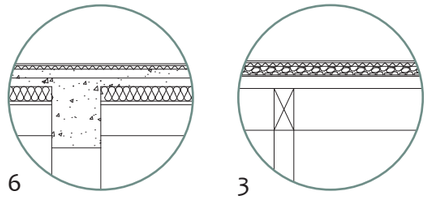
1

Terrace



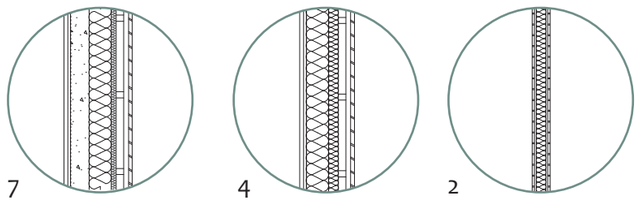
5

Slab



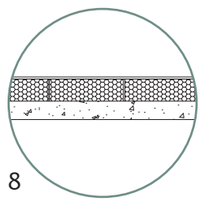
6 3

Inner & outer wall



7 4 2

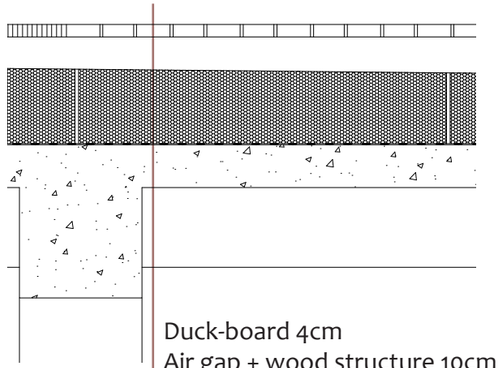
Foundation



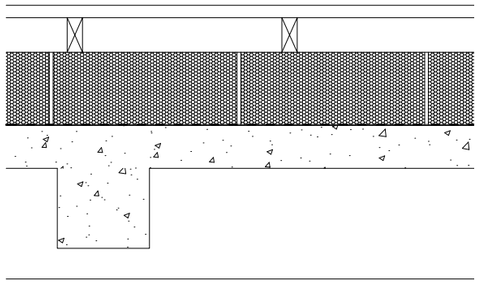
8

ACCESSIBLE ROOF - EXISTING STRUCTURE

Detail section 1 & 2:



Duck-board 4cm
Air gap + wood structure 10cm
Foam glass > 20cm (slope 1%)
Bitumen primer
Concrete slab 14cm



On the existing roof that will be used as a terrace, the insulation layer is made of Foamglas. Between the blocks, there is a liquid bitumen that assures the junction and the waterproofing of the insulation. On top of that, lies a wooden structure able to support the duck-board.

U-value:

	Section 1	λ [W/(mK)]	Section 2	λ [W/(mK)]	Total width Thickness [mm]
1.	Duck-board				
2.	Air gap		Timber frame		
3.	Foam glass	0,036			220
4.	Bitumen primer	0,230			
5.	Concrete structure	2,400			140

Section 2 percent	Sum
9%	36,0cm

U-value: 0,158 W/(m²K)

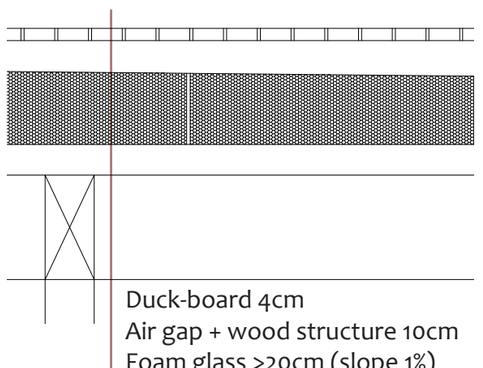
LCA:

Area 151 m²

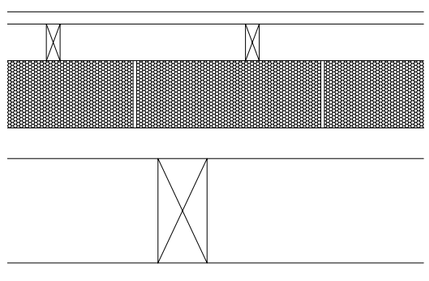
Type	Material	Thickness	cc	Trp km	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]
Wood	Lumber tech dried	0,04	-	50	1	0	0,02
Wood	Lumber tech dried	0,10	1	50	2	12	0,05
Proofing film	Bitumen	0,20	0,01	50	0	1	0,00
Insulation	Foam glass	0,20	0,99	70	8	0	0,07
Concrete	Normal concrete	0,14	-	0	0	0	0,00
Climate emission Roof 1					10	12	0,13

ACCESSIBLE ROOF - NEW STRUCTURE

Detail section 1 & 2:



Duck-board 4cm
Air gap + wood structure 10cm
Foam glass >20cm (slope 1%)
Wood plank tongue & groove 10cm
Wooden structure 34x16cm
(Span = 6m & 3,8m)



U-value:

	Section 1	λ [W/(mK)]	Section 2	λ [W/(mK)]	Total width Thickness [mm]
1.	Duck-board				
2.	Air gap		Timber frame		
3.	Foam glass	0,036	Bitumen	0,230	220
4.	Bitumen				
5.	Wood plank	0,130			100

Section 2 percent	Sum
2%	32cm

U-value: 0,153 W/(m²K)

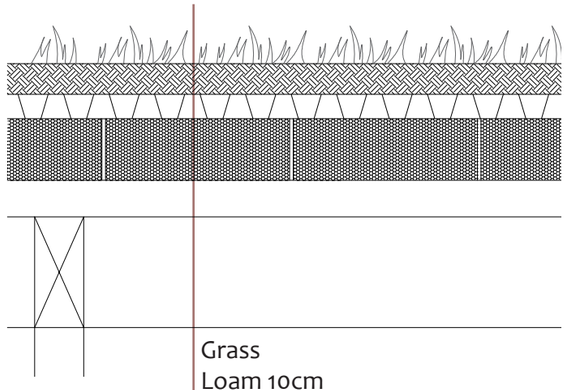
LCA:

Area 121 m²

Type	Material	Thickness	cc	Trp km	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]
Wood	Lumber tech dried	0,04	-	35	0	0	0,00
Wood	Lumber tech dried	0,1	0,05	50	1	5	0,02
Insulation	Foam glass	0,20	0,99	70	6	0	0,05
Proofing film	Bitumen	0,20	0,01	50	0	0	0,00
Wood	Lumber tech dried	0,10	1	50	1	10	0,04
Wood	Lumber tech dried	0,16	0,15	34	0	2	0,01
Climate emission Roof 1					8	17	0,12

GREEN ROOF - NEW STRUCTURE

Detail plan:



Grass
Loam 10cm
Humidity layer 8cm
Foam glass 20cm
Wood plank tongue & groove 12cm
Wooden structure 36x16cm

A green roof, covered with carefully selected plants, appears to be the ideal option. Such roofs have many advantages. It helps to absorb rain, in opposition to most of the surfaces in a city that are not permeable to water. It decreases the urban heat island effect which is responsible for a higher temperature inside a city than in the surroundings, and it is also better for biodiversity. It captures CO_2 and it has an aesthetic more pleasant for the neighbours.

U-value:

	Section 1	λ [W/(mK)]	Section 2	λ [W/(mK)]	Total width Thickness [mm]
1.	Loam	0,750			100
2.	Humidity layer	-			80
3.	Foam glass	0,036	Bitumen	0,230	200
4.	Wood plank	0,130			120

Section 2 percent	Sum
1%	50cm

U-value: 0,153 W/(m²K)

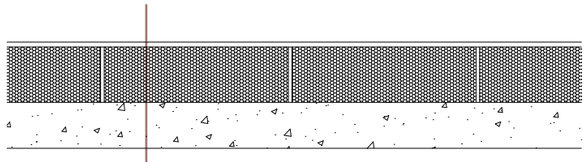
LCA:

Area	364	m²	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]

Type	Material	Thickness	cc	Trp km			
Other	Plant substrate	0,1	1	20	0	0	0,04
Proofing film	Polyethylene	0,05	1	50	59	0	0,11
Proofing film	Bitumen	0,20	0,01	50	0	0	0,00
Insulation	Foam glass	0,20	0,99	70	18	0	0,16
Wood	Lumber tech dried	0,12	1	50	5	36	0,14
Wood	Lumber tech dried	0,16	0,15	35	1	7	0,02
Climate emission Roof 1					84	43	0,47

FOUNDATION

Detail section:



Wood flooring 1,6cm
Vapour proof
Foam glass 18cm
Water proof
Concrete slab 15cm

To insulate the ground floor, the insulation from above has been preferred to facilitate the work but it is also possible as the ceiling height is important, on the ground floor there are 4m.

U-value:

	Section 1	λ [W/(mK)]	Section 2	λ [W/(mK)]	Total width Thickness [mm]
1.	Wood floor	0,140			16
2.	Foam glass	0,036			180
3.	Concrete slab	2,400			150

Section 2 percent	Sum
-%	34,6cm

U-value: 0,185 W/(m²K)

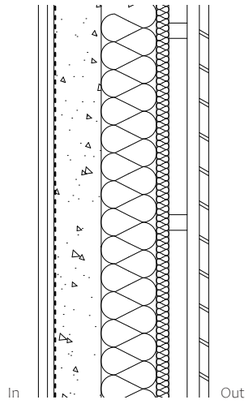
LCA:

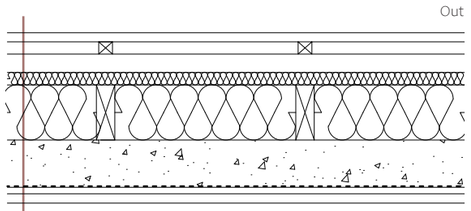
Area	121	m²	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]

Type	Material	Thickness	cc	Trp km			
Wood	Lumber tech dried	0,015	-	35	0	0	0,00
Insulation	Foam glass	0,18	1	70	23	0	0,20
Concrete	Normal concrete	0,15	-	0	0	0	0,00
Climate emission Roof 1					25	0	0,20

OUTER WALL - EXISTING STRUCTURE

Detail section & plan:





To assure a good insulation double layer of Steico is placed limiting also thermal bridges.

Wood cladding 3cm
Air gap + wooden structure 4cm
Rain barrier Steico 6cm
Steico flex F 036 4cm
Steico flex F 036 + wooden structure 18cm
Concrete 15cm
Vapour barrier
Wooden board 2,5cm
Clay board 3cm

U-value:

	Section 1	λ [W/(mK)]	Section 2	λ [W/(mK)]	Total width Thickness [mm]
1.	Wood cladding				
2.	Air gap	-	Timber		
3.	Rain barrier	0,046			60
4.	Steico flex F 036	0,036			40
5.	Steico flex F 036	0,036			180
6.	Concrete	2,4			150
7.	Wood board	0,130			25
8.	Clay board	0,130			30

Section 2 percent	Sum
7%	50cm

U-value: 0,148 W/(m²K)

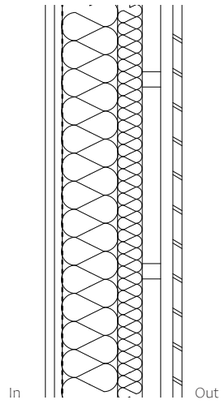
LCA:

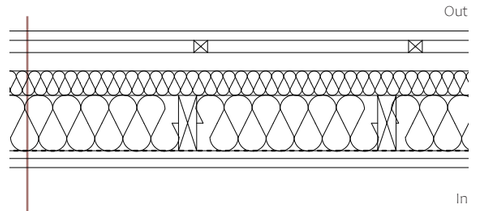
Area	1369	m²	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]

Type	Material	Thickness	cc	Trp km			
Wood	Lumber tech dried	0,03	-	35	0	0	0,00
Wood	Lumber tech dried	0,04	0,07	50	0	3	0,00
Wood	Lumber tech dried	0,06	1	50	9	67	0,09
Wood	Lumber tech dried	0,18	0,07	50	2	14	0,02
Insulation	Wood fibre	0,18	0,93	900	33	63	3,64
Concrete	Normal concrete	0,15	-	0	0	0	0,00
Wood	Lumber tech dried	0,025	1	35	4	28	0,03
Concrete	Clay board	0,03	1	60	4	4	0,06
Climate emission Existing outer wall					52	179	3,8

OUTER WALLS - NEW STRUCTURE

Detail section & plan:





Wood cladding 3cm
Air gap + wooden structure 4cm
Rain barrier Steico 6cm
Steico flex F 036 8cm
Steico flex F 036 + wooden structure 18cm
Vapour barrier
Wooden board 2,5cm
Clay board 3cm

U-value:

	Section 1	λ [W/(mK)]	Section 2	λ [W/(mK)]	Total width Thickness [mm]
1.	Wood cladding				
2.	Air gap		Timber	0,130	
3.	Rain barrier	0,046			60
4.	Steico flex F 036	0,036			80
5.	Steico flex F 036	0,036	Timber	0,130	180
6.	Wood plank	0,130			25
7.	Clay board	0,130			30

Section 2 percent	Sum
10%	37,5cm

U-value: 0,113 W/(m²K)

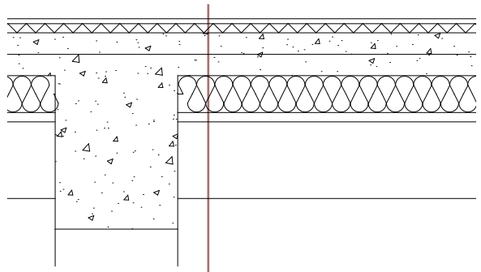
LCA:

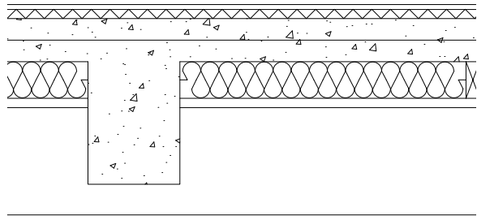
Area	541	m²	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]

Type	Material	Thickness	cc	Trp km			
Wood	Lumber tech dried	0,03	-	50	0	0	0,00
Wood	Lumber tech dried	0,04	0,1	50	0	2	0,00
Wood	Lumber tech dried	0,06	1	50	3	27	0,10
Insulation	Wood fibre	0,08	1	900	6	12	10,47
Insulation	Wood fibre	0,18	0,9	900	13	24	2,41
Wood	Lumber tech dried	0,18	0,1	35	1	7	0,03
Wood	Lumber tech dried	0,025	1	35	0	11	0,00
Concrete	Clay board	0,03	1	60	1	1	0,04
Climate emission New outer wall					24	84	13,05

INTERMEDIATE FLOOR - EXISTING STRUCTURE

Detail section 1 & 2:





Wood flooring 1,4cm
Soft board 3cm
Concrete slab 14cm
Cellulose 12cm
Wood plank 3cm

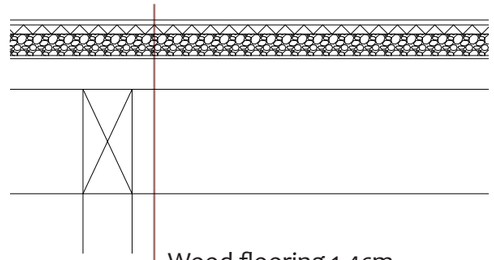
To insulate acoustically the floors, I opted to use cellulose. It has a good capacity to reduce noises and it is natural moreover to ensure phonetic insulation, a soft board is also added. This will play a role to decrease mainly the noises resulting from impact.

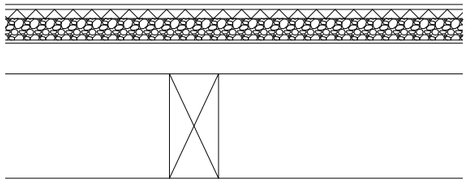
LCA:

Area	1.758	m²			Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]
Type	Material	Thickness	cc	Trp km			
Wood	Lumber tech dried	0,03	1	50	6	43	0,16
Insulation	Wood fibre	0,12	1	50	31	58	0,51
Concrete	Normal concrete	0,14	-	0	0	0	0,00
Wood	Fire board	0,03	1	50	18	20	0,20
Wood	Lumber tech dried	0,014	-	35	0	0	0,05
Climate emission Roof 1					55	121	0,92

INTERMEDIATE FLOOR - NEW STRUCTURE

Detail section 1 & 2:





Wood flooring 1,4cm
Soft board 3cm
Gravel 7cm
Paper
Wood plank 10cm
Wooden structure 16x34cm

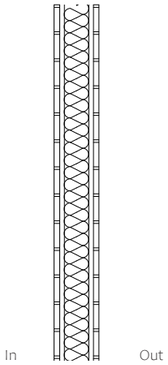
For the new structure, a layer of gravel will play the role of acoustic insulation, and to avoid the spread of dust, a paper is placed underneath.

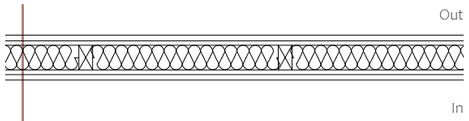
LCA:

Area	733	m²			Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]
Type	Material	Thickness	cc	Trp km			
Wood	Lumber tech dried	0,16	0,1	50	1	10	0,04
Wood	Lumber tech dried	0,1	1	50	8	60	0,23
Other	Paper	0,002	1	50	4	0	0,00
Concrete	Gravel	0,07	1	25	0	3	0,29
Wood	Fibre board	0,03	1	50	7	8	0,08
Wood	Lumber tech dried	0,014	-	35	0	0	0,02
Climate emission Roof 1					20	81	0,66

INNER WALL

Detail section & plan:





Wood cladding 1,8cm
Gypsum board 1,5cm
Steico F flex 038 + wooden structure 8cm
Gypsum board 1,5cm
Wood cladding 1,8cm

LCA:

Area 1.979 m²

Type	Material	Thickness	cc	Trp km	Emissions [ton CO_2-eq]	Storage [ton CO_2-eq]	Transp [ton CO_2-eq]
Wood	Lumber tech dried	0,018	-	35	0	0	0,00
Mortar	Lime plaster	0,015	1	3	7	0	0,02
Wood	Lumber tech dried	0,08	0,1	35	0	1	0,00
Insulation	Wood fibre	0,08	0,9	900	21	39	6,15
Mortar	Lime plaster	0,015	1	3	7	0	0,02
Wood	Lumber tech dried	0,018	-	35	0	0	0,00
Climate emission Roof 1					35	40	6,19

RESULTS

Thanks to those LCA tables, it can be seen that the materials already on site are not responsible for the emission of CO_2, as their LCA has already been taken into account. This specificity can also be found in the re-used materials apart from the CO_2 released from the transport.
Those tables show that some materials, such as Foamglas, emit a more important quantity of CO_2. However, it can be observed in the U-value tables that they are needed to ensure good performances of the building's envelope.
The wooden materials have the ability to store CO_2 during their growth which can help to balance the CO_2 emission, but for re-used materials it is not taken into account.

ENERGY EFFICIENCY

To understand the improvements done to the building, I made use of the program PHPP. Based on different data such as the area of the walls, the windows surface, the orientation, the flooring area, the composition of the elements, it is possible to calculate the performances of the building. And in the end, it allows me to compare the results from the existing building and the renovated version.
In Brussels, every new building or renovation project in the residential sector has to consume less than 100kWh/m²y primary energy (Bruxelles Environnement, 2019). It gave me a first idea of what I have to expect at least.
By changing the windows to more efficient ones, insulate properly the roofs, the walls, and the foundation the specific heat demand dropped to 30kWh/m²y, considering a temperature of 21°C (See appendix C).

Specific heat demand : **30kWh/m²y**

HEATING SYSTEM

In Belgium, a district heating system is not very common. However, it exists in Brussels in the new neighbourhood of Bervoets. And due to its positive impact on the environment, Belgium considers extending this solution to more areas, (Frippiat, J. & Haveaux, C., 2020).
It works a bit like central heating but on a larger scale. It heats up water before sending it to buildings through well-insulated underground pipes. Cold-water will come back to the central afterwards.
The advantages to this system are the collective aspect, one big installation will consume less than a lot of individual ones. It is also easier for the citizens as they only have to pay for what they consume and they do not have to worry about reparations or maintenance. Other heating sources, unusable by smaller boilers, can be exploited.
However, to ensure the efficiency of this system, it is important to have perfect insulation for the underground pipes. This system works better in a denser area and its initial cost is significant.
As this renovation project would be a long process (to get the planning permission, the detail design, and the construction), the assumption has been made to use a district heating system, as it is more efficient and more environment-friendly.

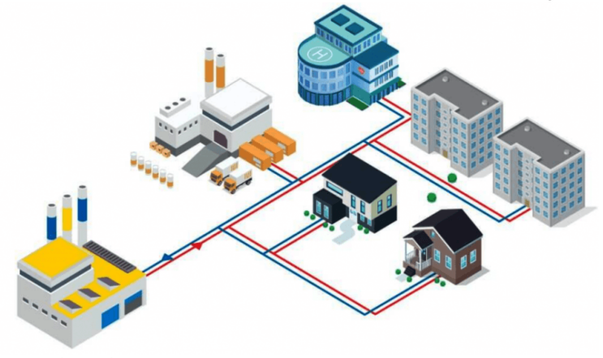


Figure 82. District heating system (Epp B.)

Architecture is a social act and the
material theatre of human activity.
– Spiro Kostof

6

– Reflections –

DISCUSSION

Before starting this master thesis I had some interest in the renovation field. My research, however, conveniently demonstrates that renovation is not only possible but also preferable in many cases. It makes sense in view of its sustainable impact and VAT is also reduced for the ones who decide to transform instead of demolishing. Transform something useless and problematic into something advantageous, better for the environment, and valued by the community around is rewarding even in this fictional case of a master thesis.

This thesis endeavours to showcase the possibility and the potential of reused buildings from a social and environmental aspect. As the overall number of vacant buildings across Europe is considerable, some similar projects to the one undertook in this master thesis have obviously been carried out by the European Union. Hopefully, more will come in the future.

Regarding our common situation, a growing population, and limited resources and land, the potential of existing buildings should be an alternative more considered. They offer a site, usually already inside the urban fabric, a majority of the materials is already on-site, with maybe some new ones needed for the renovation, they also offer a story, the existing building had a previous life that can be integrated into the renovation.
In this thesis, I explored the 3 aspects of sustainability, economic, social, and environmental, through the project proposal.

The choice of the program has been designed after a theoretical analysis of the area around and what the community may need. In a real-life project, citizens' involvement and planning participation would be favourable although not feasible within the master thesis framework. The building at stake is situated in a neighbourhood with a poor reputation. My bet is that architecture can partly help to change for better as it is a key element to improve the general feeling of a city. Invest in the architecture in municipalities with issues can avoid some problems: those empty structures are often a source of squatting and insecurity, transforming them would prevent this from happening and would propose more housings and jobs.
The economical aspect is less covered but it is mainly treated by reusing an existing building. It is also done regarding the materials used for the renovation as a part of them are re-used the overall price may probably decrease a bit.

The environment aspect was probably the stronger driving force. This led to reuse the existing instead of building new. It improves its energy efficiency and therefore reduces CO_2 emission. The new materials chosen for the renovation were also selected from an environment-friendly perspective.

This thesis provides an idea of how a transformation project could be conducted. It suggests a (out of many) solution for a specific site, but some of the ideas can be reused somewhere else.

RESEARCH QUESTIONS

- *How can the transformation of an existing building help to reduce the present/future mankind's footprint by the reuse of the building and make it more environment-friendly?*

The first research question covers the subject of environmental sustainability. It has been treated through the study cases, showing what has already been done, giving some ideas to inspire. Afterwards, environmental sustainability has been carried out in the design proposal. Offering one example of how this concept of renovation can be implemented in a clear framework, showing also the new composition of the wall to improve the building energy efficiency.
The details are shown with a double objective: the first one is to demonstrate how the renovation part can be dealt with and the latter is to put forward an alternative for new materials with re-used ones.

- *How can architecture socially support a neighbourhood?*
  In an urban context, how can a building influence people's behaviour?
  In a very dense area, can the creation of a social hub and housing improve the general feeling in a neighbourhood?

The second question is about how architecture can have a social effect on the community around and how architecture can be useful and appreciated by the community around.
This question is harder to measure, in the reality it would be very valuable to get participation from the citizens. Nevertheless, in this master thesis, social sustainability was mainly answered thanks to a theoretical analysis of the area, thanks to the new program of the building.

DESIGN FINDINGS AND CONCLUSION

Thanks to this project I had the chance to dig more into the field of renovation. I understood some issues that can be faced during such a process, and how they can be solved. The process of (re)designing an existing project is different from what I have learned so far during my studies.

Some questions were already solved but new ones appeared, with the inherent difficulty that I am not the one who designed the original building and I could visit it only once. This led me to take more time to understand correctly the building. Once this step was passed, I was able to let creativity play a bit more freely with it, especially thanks to the columns beams system.

Looking for re-used materials made me very positive, I discovered that initiatives like gathering existing construction components, were taking more importance. It makes a circular economy, in terms of materials, more accessible and much easier.

Be the change that you wish to see
in the world.
– Mahatma Gandhi

7

– End notes –

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LIST OF FIGURES

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Figure 67 Atmosphère & bois. (n.d.). *Bois échafaudage brossé* [Photograph]. Retrieved April 6, 2021 from https://www.atmosphere-bois.com/europe/wp-content/uploads/2021/03/AB_CATALOGUE_BARDAGE_2021.02_WEB.pdf

Figure 68 Rotor Deconstruction (n.d.). *Batch of speckled 'anthracite' stoneware tiles* [Photograph]. Retrieved April 20, 2021, from https://rotordc.com/product/batch-of-speckled-anthracite-stoneware-tiles-63-sqm/

Figure 69 Rotor Deconstruction (n.d.). *Speckled light grey ceramic tiles 'Welkenraedt' from the St. Elisabeth Nursing School in Leuven* [Photograph]. Retrieved April 20, 2021, from https://rotordc.com/product/speckled-light-grey-ceramic-tiles-welkenraedt-from-the-st-elisabeth-nursing-school-in-leuven-151-mm/

Figure 70 Rotor Deconstruction (n.d.). *Batch of speckled dark grey porcelain stoneware tiles* [Photograph]. Retrieved April 20, 2021, from https://rotordc.com/product/batch-of-speckled-dark-grey-porcelain-stoneware-tiles-10-sqm/

Figure 71 Atmosphère & bois. (n.d.). *Recycled flooring: train car flooring* [Photograph]. Retrieved April 20, 2021, from https://www.atmosphere-bois.com/europe/wp-content/uploads/2021/03/AB_CATALOGUE_PLANCHER_ANCIEN_032021_WEB.pdf

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APPENDIX A

Verbetering van de verwarmingsinstallatie

			Impact	x Rentabiliteit	x Frequentie	= Prioriteit
Warmwaterproductie						
1	Een diagnoserapport laten opstellen door een erkende verwarmingstechnicus of een EPB verwarmingsadviseur *...afhankelijk van het vermogen en het aantal verwarmingsketels...*		3	3	3	27
2	Vervangen van de verwarmingsketel en de brander *Tot 15%*		3	2	3	18
3	Het vermogen van de bestaande brander verminderen (een kleinere sproeier monteren) *...1%...*	?	1	3		-
4	Verwarmingsketels uitrusten met een systeem zodat ketels en branders in cascade kunnen werken *0,5% tot 2%*	?	1	1		-
5						
6						
7						
Warmwaterdistributie en afgifte						
1	De snelheid van circulatiepompen met verschillende snelheden verlagen *... 40...% van het stroomverbruik van de circulatiepompen*		3	3	3	27
2	De bestaande circulatiepompen vervangen door circulatiepompen met variabele snelheid *40 ... 50 % van het verbruik van de circulatiepomp*		3	2	3	18

APPENDIX B

GLOSSARY PARA-MEDICAL CENTRE

The psychologist's approach always aims to listen and understand with respect and kindness who the child is, his family, his loved ones, and what they are going through
it is also the framework that allows the child to be supported and to try to overcome his fears, to manage his emotions, to face his difficulties. The psychologist's job is to help the child grow up, to empower himself, to accept himself by having confidence in him. (Aleternatives, N.D.)
The speech therapist is the paramedical professional who deals with disorders of language, speech, voice, hearing, and the primary functions of the mouth (sucking, swallowing, and chewing). (Service Centre Santé, 2019)
Neuropsychology attempts to relate mental processes and behaviors related to the brain and its functioning. It is divided into two aspects: the assessment (for diagnostic purposes) and support (rehabilitation, remediation, stimulation, compensation). (Aleternatives, N.D.)
Physiotherapy is a paramedical discipline which uses techniques based on movement, with the aim of developing, optimizing, maintaining, or restoring the best physiological and in particular motor functions. (Aleternatives, N.D.)
The occupational therapist treats, accompanies, and advises people confronted with a physical injury or illness, psychosocial problems, cognitive problems, developmental, or learning disorders or the aging process. (Service Centre Santé, 2016)
Psychomotricity consists in re-educating the disorders linked to psychological disturbances experienced and expressed in a bodily way. (Passeport santé, n.d.)
The general practitioner is the first point of contact for health problems in the broad sense. It is up to him to keep an overview of the general state of health of his patients, he is the coordinator of all the care they need. (Service Centre Santé, 2019)
Social worker listens to, supports and accompanies people in difficulty to guide them towards better social integration (Le guide social, 2017).

APPENDIX C

PHPP - AREA

Grupp nr	Areagrupp	Tempe-ratur	Area	En-het	Kommentar	Byggnadsdel översikt	Genomsnittligt U-värde
1	Referensarea		2491,00	m²	*Boarea enligt WoflV eller lokalarea enligt DIN 277 innanför klimatskalet.*		
2	Windows north	A	31,58	m²		Windows north	0,732
3	Windows east	A	407,86	m²		Windows east	0,769
4	Windows south	A	15,65	m²	Resultat från kalkylbladet "Fönster"	Windows south	0,785
5	Windows west	A	160,27	m²		Windows west	0,768
6	Windows roof	A	0,00	m²		Windows roof	
7	Doors	A	22,75	m²	*Minska motsvarande byggnadsdel med ytterdörrens are.*	Doors	0,153
8	Walls towards air	A	1209,85	m²	*Fönsterareor subtraheras från de enskilda areorna på bladet "Fönster"*	Walls towards air	0,185
9	Walls towards ground	B	700,85	m²	*Temperaturzon "A" är uteluft*	Walls towards ground	0,185
10	Roof	A	790,00	m²	*Temperaturzon "B" är mark*	Roof	0,158
11	Foundation	B	504,00	m²		Foundation	0,140
um envelope			3842,80	m²		Genomsnitt byggnadsskal	0,267

Fill in areas below:

1	Wall south	8	Walls towards air	1	x (		x		+	183,38	-		) -	15,7	=	167,7	Foundation	1	0,185
2	Wall west	8	Walls towards air	1	x (		x		+	506,97	-		) -	160,3	=	346,7	Foundation	1	0,185
3	Wall north	8	Walls towards air	1	x (		x		+	157,54	-		) -	31,6	=	126,0	Foundation	1	0,185
4	Wall east	8	Walls towards air	1	x (		x		+	977,31	-		) -	407,9	=	569,4	Foundation	1	0,185
5	Roof	10	Roof	1	x (		x		+	790,00	-		) -	0,0	=	790,0	Roof terrace	2	0,158
6	Foundation	11	Foundation	1	x (		x		+	504,00	-		) -	0,0	=	504,0	Outter wall	3	0,140
7					x (		x		+		-		) -	0,0	=			7	
8	Door	7	Doors	1	x (		x		+	22,75	-		) -	0,0	=	22,8	Roof type 2	5	0,153
9	Floor area: 3rd floor	1	Referensarea	1	x (		x		+	425,00	-		) -	0,0	=	425,0		0	
10	Floor area: Second floo	1	Referensarea	1	x (		x		+	702,00	-		) -	0,0	=	702,0		0	
11	Floor area: First floor	1	Referensarea	1	x (		x		+	641,00	-		) -	0,0	=	641,0		0	
12	Floor area: Entrance fl	1	Referensarea	1	x (		x		+	415,00	-		) -	0,0	=	415,0		0	
13	Floor area : 4th floor	1	Referensarea	1	x (		x		+	308,00	-		) -	0,0	=	308,0		0	
14	Wall South	9	Walls towards ground	1	x (		x		+	43,55	-		) -	0,0	=	43,6	Foundation	1	0,185
15	Wall West	9	Walls towards ground	1	x (		x		+	614,12	-		) -	0,0	=	614,1	Foundation	1	0,185
16	Wall North	9	Walls towards ground	1	x (		x		+	43,18	-		) -	0,0	=	43,2	Foundation	1	0,185

PHPP - WINDOWS

					Total window size		Wall/roof		Glass		Frame	
#	Description	angle from north	inclination	orientation	width	height	From "areas"	Nr	from "windowtype"	Nr	from "windowtype"	Nr
		grader	grader		m	m	Välj:		Välj:		Välj:	
2	Type 1 South	180	90	South	2,000	2,300	Wall south	1	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 2 South	180	90	South	1,500	3,000	Wall south	1	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 3 South	180	90	South	1,500	0,700	Wall south	1	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 4 South	180	90	South	1,500	0,600	Wall south	1	Good glazing argon	1	Nordan passiv 120x140	1
4	Type 1 West	270	90	West	1,200	1,400	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
19	Type 2 West	270	90	West	2,000	1,900	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 3 West	270	90	West	2,000	6,100	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 4 West	270	90	West	3,150	6,100	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 5 West	270	90	West	2,900	2,800	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
3	Type 6 West	270	90	West	2,400	1,900	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 7 West	270	90	West	1,800	1,900	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
6	Type 8 West	270	90	West	0,800	1,000	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
5	Type 9 West	270	90	West	0,600	1,900	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
							Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 11 West	270	90	West	1,800	2,100	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 12 West	270	90	West	1,050	1,100	Wall west	2	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 1 North	0	90	North	2,900	2,800	Wall north	3	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 2 North	0	90	North	0,600	2,100	Wall north	3	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 3 North	0	90	North	2,160	6,100	Wall north	3	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 4 North	0	90	North	1,500	0,600	Wall north	3	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 1 East	90	90	East	3,500	2,500	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
28	Type 2 East	90	90	East	2,440	1,900	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
4	Type 3 East	90	90	East	1,500	2,900	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 4 East	90	90	East	1,500	1,900	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 5 East	90	90	East	2,300	1,900	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
3	Type 6 East	90	90	East	1,900	2,000	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
10	Type 7 East	90	90	East	2,440	2,800	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
18	Type 8 East	90	90	East	1,200	2,000	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
18	Type 9 East	90	90	East	0,500	2,000	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 10 East	90	90	East	1,400	2,100	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 11 East	90	90	East	4,500	2,400	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
9	Type 12 East	90	90	East	1,220	2,400	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 13 East	90	90	East	4,230	1,400	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
2	Type 14 East	90	90	East	2,700	3,300	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 15 East	90	90	East	3,200	2,800	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1
1	Type 16 East	90	90	East	2,000	2,100	Wall east	4	Good glazing argon	1	Nordan passiv 120x140	1

PHPP - SHADING

Number	Description	angle from north	inclination	orientation	width	hight	Glass area	Height of shading object / horizon	distance to shading object / horizon	Window flanning depth	Distance glass – facade (horizontal)	Overhang, depth (horizontal distance from glass)	Distance from top glass edge to overhand (vertical distance)	Extra reduction
		degrees	degrees		m	m		m	m	m	m	m	m	%
					b_F	h_F	A_F	h_{Hori}	a_{Hori}	u_{reveal}	a_{reveal}	u_{upper}	a_{upper}	r_{other}
2	Type 1 South	180	90	South	1,76	2,02	7,1	65,00	146,00	0,20	0,000	0,20	0,00	90%
1	Type 2 South	180	90	South	1,26	2,72	3,4	65,00	146,00	0,20	0,000	0,20	0,00	90%
1	Type 3 South	180	90	South	1,26	0,42	0,5	65,00	146,00	0,20	0,000	0,20	0,00	90%
1	Type 4 South	180	90	South	1,26	0,32	0,4	65,00	146,00	0,20	0,000	0,20	0,00	90%
4	Type 1 West	270	90	West	0,96	1,12	4,3	34,00	73,00	0,20	0,000	0,20	0,00	90%
19	Type 2 West	270	90	West	1,76	1,62	54,2	34,00	73,00	0,20	0,000	0,20	0,00	90%
1	Type 3 West	270	90	West	1,76	5,82	10,2	34,00	73,00	0,20	0,000	0,20	0,00	90%
1	Type 4 West	270	90	West	2,91	5,82	16,9	73,00	73,00	0,20	0,000	0,20	0,00	90%
2	Type 5 West	270	90	West	2,66	2,52	13,4	4,00	73,00	0,20	0,000	0,20	0,00	90%
3	Type 6 West	270	90	West	2,16	1,62	10,5	34,00	73,00	0,20	0,000	0,20	0,00	90%
1	Type 7 West	270	90	West	1,56	1,62	2,5	34,00	73,00	0,20	0,000	0,20	0,00	90%
6	Type 8 West	270	90	West	0,56	0,72	2,4	34,00	73,00	0,20	0,000	0,20	0,00	90%
5	Type 9 West	270	90	West	0,36	1,62	2,9	34,00	73,00	0,20	0,000	0,20	0,00	90%
					-0,24	-0,28	0,0	34,00	73,00	0,20	0,000	0,20	0,00	90%
1	Type 11 West	270	90	West	1,56	1,82	2,8	34,00	73,00	0,20	0,00	0,20	0,00	90%
2	Type 12 West	270	90	West	0,81	0,82	1,3	34,00	73,00	0,20	0,00	0,20	0,00	90%
2	Type 1 North	0	90	North	2,66	2,52	13,4							
1	Type 2 North	0	90	North	0,36	1,82	0,7							
1	Type 3 North	0	90	North	1,92	5,82	11,2							
1	Type 4 North	0	90	North	1,26	0,32	0,4							
2	Type 1 East	90	90	East	3,26	2,22	14,5	35,00	30,00	0,20	0,00	0,20	0,00	90%
28	Type 2 East	90	90	East	2,20	1,62	99,8	35,00	30,00	0,20	0,00	0,20	0,00	90%
4	Type 3 East	90	90	East	1,26	2,62	13,2	35,00	30,00	0,20	0,00	0,20	0,00	90%
2	Type 4 East	90	90	East	1,26	1,62	4,1	35,00	30,00	0,20	0,00	0,20	0,00	90%
2	Type 5 East	90	90	East	2,06	1,62	6,7	35,00	30,00	0,20	0,00	0,20	0,00	90%
3	Type 6 East	90	90	East	1,66	1,72	8,6	35,00	30,00	0,20	0,00	0,20	0,00	90%
10	Type 7 East	90	90	East	2,20	2,52	55,4	35,00	30,00	0,20	0,00	0,20	0,00	90%
18	Type 8 East	90	90	East	0,96	1,72	29,7	35,00	30,00	0,20	0,00	0,20	0,00	90%
18	Type 9 East	90	90	East	0,26	1,72	8,0	35,00	30,00	0,20	0,00	0,20	0,00	90%
1	Type 10 East	90	90	East	1,16	1,82	2,1	35,00	30,00	0,00	0,00	0,20	0,00	90%
2	Type 11 East	90	90	East	4,26	2,12	18,1	35,00	30,00	0,20	0,00	0,20	0,00	90%
9	Type 12 East	90	90	East	0,98	2,12	18,7	35,00	30,00	0,20	0,00	0,20	0,00	90%
1	Type 13 East	90	90	East	3,99	1,12	4,5	35,00	30,00	0,20	0,00	0,20	0,00	90%
2	Type 14 East	90	90	East	2,46	3,02	14,9	35,00	30,00	0,20	0,00	0,20	0,00	90%
1	Type 15 East	90	90	East	2,96	2,52	7,5	35,00	30,00	0,20	0,00	0,20	0,00	90%
1	Type 16 East 9	90	90	East	1,76	1,82	3,2	35,00	30,00	0,20	0,00	0,20	0,00	90%

PHPP - SUM

Year of completion	2019			Internal heat loads
Number of apartments	1	Indoor temp	21,0	°C
Volume V_e	6725,7 m^3	Internal heat gains	3,5	W/m^2
# persons	25,0			

Specifika värden relaterade till referensarean

Referensarea: 2491,0 m^2

	Metod:	Month method	PH certifikat:	Uppfyllt?
Specific heat demand:	**28**	**kWh/(m^2a)**	**15 kWh/(m^2a)**	**no**